POWER

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The N. A. S. E.

NEXT week the National Association of Stationary Engineers will hold its fortieth annual convention at Des Moines

In the twoscore of years that have elapsed since its organization, this association has enjoyed an exceptional opportunity.

The use of power and the importance of the power-plant engineer to the community have increased by leaps and bounds.

At the same time and in the same city that the National Association of Stationary Engineers was organized, the first electric central station was built.

Up to that time the show plant of the steam engineer was the public pumping station, and the high-duty pumping engine was the holder of his record performance.

Industrial plants were of moderate size and simple design, the compound engine an interesting innovation; coal was conveyed and fired by hand, no stokers, no superheat. Transmission was by belts, rope drives and rattling gears. Boiler pressures have increased from around one hundred to over two hundred pounds for common use and to four hundred in the most advanced practice. Refrigeration has developed from a small industry into what must soon be recognized as a great public utility. The price of fuel has trebled and quadrupled.

The growth of the association has been contemporaneous with that of the electrical industry. The apprehension of the stationary engineer that he was to be annihilated by the central station has eventuated with the recognition of the fact that electricity is made by power, that the more electricity that there is used the more power is required to make it, and that the grand-scale production, while it means the suppression of many small, inefficient plants, offers undreamed-of opportunities to the steam engineer of sufficient ability to embrace them.

The man who used to go to the N.A.S.E. meeting in a horse-car now goes in the then undreamed-of subway or automobile.

The big outstanding men in the power-plant end of this development are members of and active participants in the work of the N. A. S. E. That is what has helped them to be big and outstanding; not just being members, but going actively after the advantages that membership in the association offers.

There are, by the last census, 242,000 men in the United States that gave their vocation as "stationary engineer." The N.A.S.E. has less than ten per cent of them in its membership.

Is it because it does not offer what they want and need or because it has not got the appreciation of its advantages over to them?

F. R. Low

Fuel Oil Shows Big Saving in Singer Building

BY NORMAN KING
Chief Engineer, Singer Building, New York City

TWO years' operation with fuel oil has shown a 34 per cent saving over coal and the installation paid for itself in 21 months. The article is written especially for those who contemplate oil burning under high-pressure boilers in New York City and therefore describes details of construction necessary to meet the Building and the Fire Departments' regulations. Nevertheless the economic results will interest a large number of readers located elsewhere.

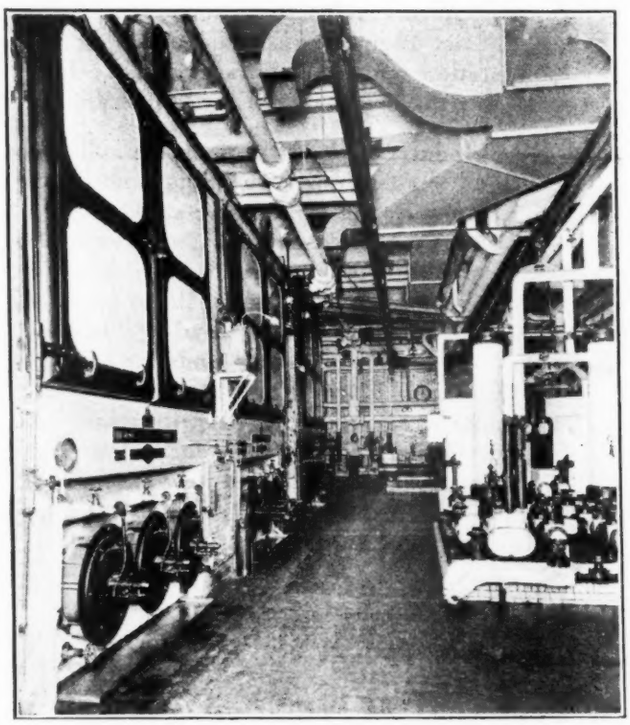
FOR the engineer who contemplates changing from coal to fuel oil, the first step is to ascertain if it is really possible to do so under the rules and regulations that govern storage of oil and equipment to burn it. He must know what it actually costs to generate steam with coal, including stand-by losses, labor, ash removal, etc., what he is paying for coal and what he would have to pay for oil. After this is determined, and if a profitable saving is indicated he must consider the reliability of supply.

Every engineer must figure on the basis of his own conditions and the particular job. When this has been decided, he should apply to the municipal authorities for a set of rules pertaining to indoor storage of fuel oil. Each rule must be well studied. If he feels assured that these rules can be met, he will be obliged to make plans that will cover every rule 100 per cent to submit to the building and fire departments for approval. It is important that all apparatus indicated on the plans be of approved type, as this will save an enormous amount of time and discouragement. Try in every case to bury the storage tanks, as this permits 100 per cent greater storage capacity.

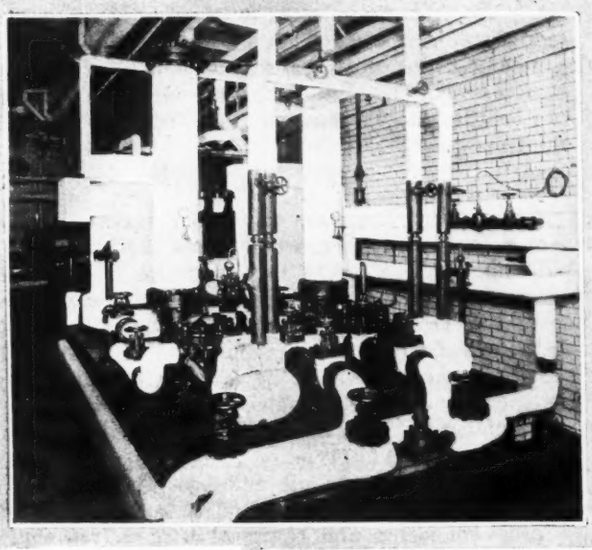
Furnace Conditions a Factor

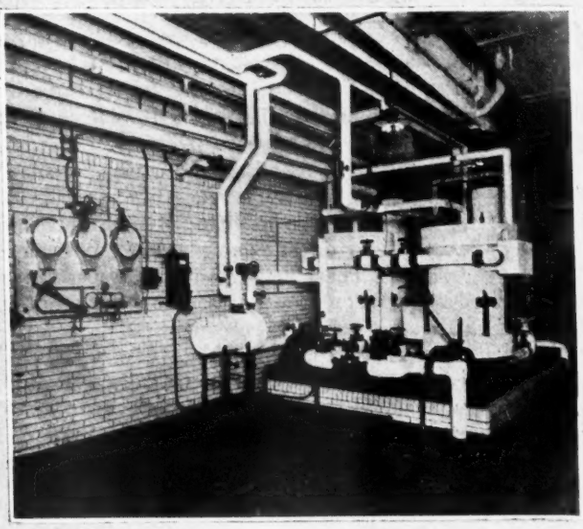
Height of boiler settings is important and is one of the weak points in the usual hand-fired boiler room in New York City. If the maximum rating is known at which it is desired to operate the boiler, it does not pay to install a greater furnace volume that will burn the required amount of oil to produce the same rating provided the heating surfaces are in a condition to receive the heat produced in the furnace. Too great a furnace volume means a cold furnace and therefore poor combustion. The type of burner is a question, steam or mechanical, requiring early decision. Where first cost counts, the steam atomizer invariably is chosen because of the lower pressures involved and stack conditions. The mechanical atomizer is best adapted where high ratings are to be considered and the human element practically cut out. Refractory furnace lining is another important item in order to keep down furnace repairs. First cost should not be considered where reliability and continuous operation are imperative. "Safety-first" is the slogan throughout. These few remarks, which are given from the writer's personal experience, may be of assistance to the engineer who is contemplating making the change.

In 1918, when coal and labor began an upward trend and one could not predict where it was going to stop, a year's operating cost with coal was checked against oil, knowing what we could purchase oil for delivered to the building. It did not require much figuring to indicate a saving of 25 per cent over coal. It was then decided to run a series of tests with a coal-fired boiler and an oil-fired boiler. These tests were conducted by the engineers of the Babcock & Wilcox Co., assisted by the engineers of the plant, with the usual weighing tanks and instruments. The result showed conclusively that we were making no mistake. These tests were conducted in 1919 and were made under the ordinary working conditions and were not "hand picked," as we were anxious to get at the real facts. In the case of the oil-fired boiler the furnace was somewhat improvised by the coal grates being dropped down toward the back and covered by checker brickwork, using two rear shot



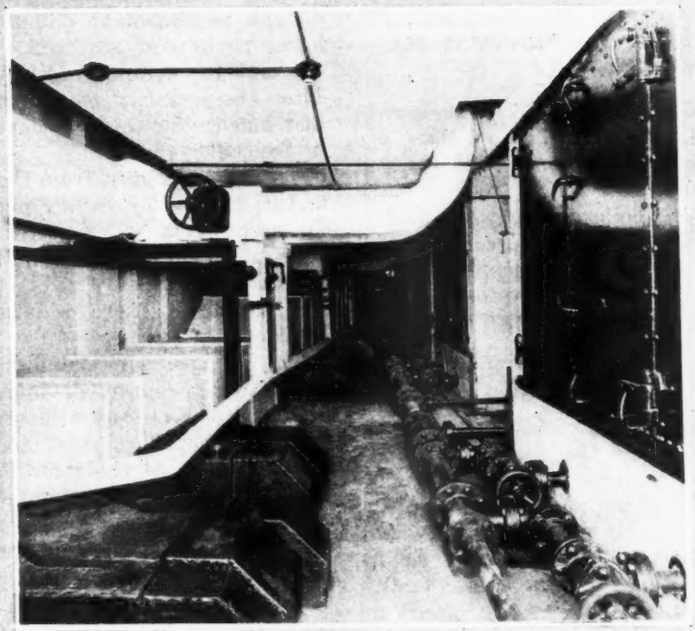
LOOKING DOWN BOILER AISLE





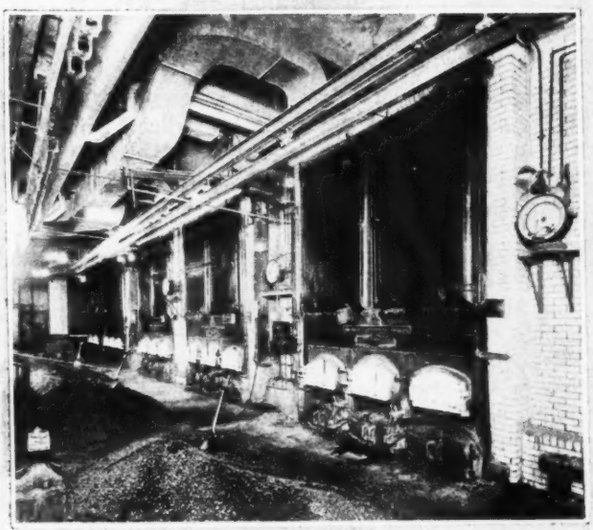
Above: These oil pumps and heaters were installed by the operating force in 8 hours, with exception of the pipe covering.

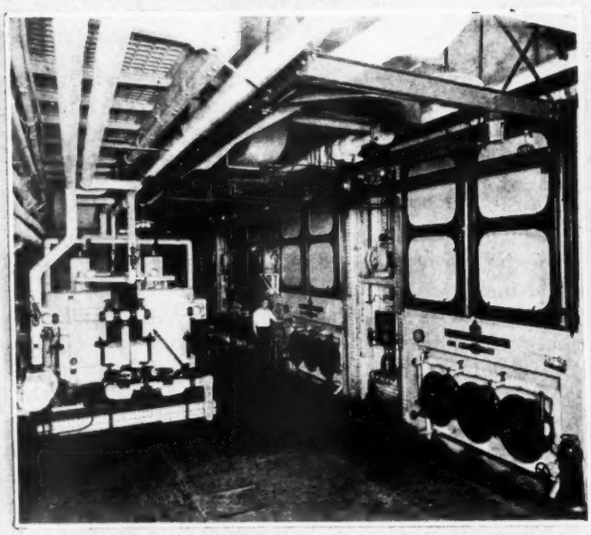
Right: Note the light and cleanliness behind the boilers.



Above: Gage board and oil heaters.

Lower Left shows boiler room when burning coal. Contrast this with view from same location (lower right) when burning fuel oil.





steam atomizers for the tests. The results were that the coal-fired boiler showed an over-all efficiency of 68 per cent against 79.6 per cent for the oil-fired boiler. This left no doubt as far as efficiency goes. In February, 1920, we began tearing out the old furnaces, and reconstructing them to meet the requirements[1] for burning oil.

The boiler plant,[2] which supplies steam for a 1,400-kw. engine plant as well as the diversified services of an office building, consists of five B. & W. units, four of which have 4,800 sq.ft. heating surface and one 3,840. They are of the cross-drum type, fitted with superheaters and are designed for an allowable working pressure of 200 lb. per sq.in. These boilers are equipped with automatic feed-water regulators, steam-flow meters and individual draft gages and CO_2 recorders. The recording apparatus and gages for recording steam pressure, etc., are located in the chief engineer's office. In the boiler room are installed three recording indicators, two for temperature and one for pressure. The first records the preheat temperature of the oil, the second the pressure of the oil delivered to the burners, and the third the temperature of the oil as it enters the pump suction.

Fuel-Oil Storage Tanks and Provisions for Preheating the Oil

The fuel oil is stored in three tanks ranging in capacity from 7,000 to 12,000 gal. Two of these are under the sidewalk in the space formerly used for coal bunkers, and one is installed in a nearby room. These tanks are made from $\frac{3}{8}$-in. boiler steel, with double-riveted lap joints and rivets spaced $2\frac{1}{2}$-in. centers. All plates are beveled, sheared and calked and were tested to a hydrostatic pressure of 35 lb. per sq.in. Each of the tanks is inclosed in a separate fireproof vault having masonry 12 in. thick, the walls of the vaults being made water and oil tight with hydrolithic cement. On the top of each tank is a concrete slab 12 in. thick, so designed as to maintain a live load of 300 lb. per sq.in. This top slab is two feet below the underside of the sidewalk, constructed so as to allow plenty of room for getting into the manholes in the slab. One manhole in the slab is directly over that in the tank, from which a ladder drops to the interior. Another manhole in the slab allows entrance by means of a ladder to the vault surrounding the tank. The tanks are placed in these vaults on structural-steel supports, and a clearance of at least twelve inches is provided all around them.

As it was desired to be able to burn almost any grade of fuel oil, provision had to be made for heating the oil in the tanks, in order that it could be pumped. This was accomplished by means of hot-water circulating coils placed within the tank. The water for this purpose is heated in a separate heater by either exhaust or live steam. An electrically driven pump circulates the hot water through the coils. As a safety precaution, along the inside of the top of each tank there is placed a pipe drilled with a large number of $\frac{1}{8}$-in. holes and so connected to the steam plant that any fire can be instantly smothered by steam from the boilers. Also, the vaults in which the tanks are set can be flooded by means of a standard fire connection above the sidewalk. The tanks are filled by means of a filling box placed in the sidewalk and connected to a system of piping which acts as a manifold. This is so arranged that either one tank or the whole battery may be filled at one time if necessary. The filling box can be locked so nothing can be run into the tank without the knowledge of the chief engineer.

Safety Precautions

A 4-in. vent line runs from each tank to a general vent 8 in. in diameter, which leads to the roof of the building. At the top of this vent pipe is a goose-neck covered with a fine wire screen to prevent any explosion emanating from the outside. Also, the vaults are vented to the street to prevent accumulation of vapors. Each tank has one high and one low suction pipe, and at the end of each is a foot-valve so designed as to prevent any siphoning action taking place when the pumps are not operating. This type of foot valve requires 11 in. of vacuum before the oil will pass through it. The high and low suction pipes lead to separate manifolds so cross-connected and equipped with valves that the oil can be drawn at will from either the top or the lower portion of any tank. Oil can be pumped from one tank to another if desirable. A Pneumercator indicates the quantity of oil in each at all times. The instruments for this apparatus are on the control board in the boiler room.

The oil is pumped from the tank through the heaters to the burners by duplex pumps installed in duplicate. To each pump is connected a separate air chamber 10 in. in diameter and 60 in. high. These air chambers equalize the pressure so as to eliminate pulsations to the burners. There is also a duplicate set of oil strainers.

The pumps, air chambers, strainers and heaters are so cross-connected, bypassed and equipped with necessary valves that oil can be pumped through either pump, air chamber, strainer and heater independently of the other. At the same time the other combination may be used for pumping oil between tanks. This allows either pump, strainer or oil heater to be cleaned without interruption of the service. It also allows bypassing if necessary or expedient. All valves are so marked as to eliminate as much as practicable the danger of making improper connections when placing them back in service.

Oil Heaters

The oil is pumped through heaters to the burners. These heaters, operating by either exhaust or live steam, are in duplicate. Each is capable of heating 4,000 lb. of oil per hour from a temperature of 90 deg. F. to 300 deg., and is equipped with relief valves for both steam and oil. These relief valves are so connected that when dangerous pressures arise, the steam supply to the pumps is cut off, thereby shutting down the system and keeping it within proper operating limits. Should these relief valves fail to work, there is another valve which acts as an automatic cutoff. The oil heaters may be bypassed through oil strainers to the main line supplying the burner, if found expedient. The entire pumping apparatus is placed in a cast-iron pan flanged 3 in. high and on a concrete foundation. The flanged pan prevents such oil as may leak from the pumps getting onto the boiler-room floor.

The heater which furnishes the hot water to the

[1] Those interested in following these proceedings are referred to the Bulletin of the Board of Standards and Appeals, Vol. VI, March 22, 1921 page 175, covering apparatus used in this fuel-oil installation.

[2] The reader is referred to a very complete description of this plant contained in the March, 1921, issue of the Texas Company's bulletin, *Lubrication*, to which the writer wishes to make acknowledgment.

coils in the storage tanks, operates on either exhaust or live steam and is equipped with an electrically driven pump for forcing the water through the coils. In the oil suction line there is a thermostatic control which cuts off the hot water from any individual tank in the event that the temperature of the oil in the tank exceeds that required. The temperature of the oil coming from the storage tanks is determined by means of thermometers at the oil end of the pumps and again in the main discharge line to the burners. Meters are installed both in the suction line and in the discharge line from the burners. The amount of oil consumed is determined by the difference in the readings of these two meters, taken at the end of every eight-hour shift. These meters are bypassed so that there will be no break in the flow in case either one should fail.

The main supply and return oil lines from the pumping equipment to the boilers are laid within a concrete trench 12 in. wide and protected with cast-iron covers. The only openings in these covers are two in front of each boiler. The supply line to the burners rises through one of these openings in front of each boiler vertically to a horizontal pipe across the top of the burners, about four feet above the floor. Lines drop from this horizontal pipe to the three burners installed in the front of each boiler. At the end of this horizontal line a return line goes back into the trench to the general return line, and the oil not used in the burners is returned to the suction end of the pump. In this line are a pressure gage and a thermometer.

The oil supply to each burner is governed by a gate valve in the burner line. Back of each burner is also a special safety valve. The function of the latter is to cut off automatically the supply of oil in case the burner becomes damaged or the special flexible tubing leading to the burner breaks. This tubing is tested to 600 lb. per sq.in., but as it is exposed and may become damaged, the special safety valve is installed as an extra precaution.

The burners are B. & W. mechanical type with a nozzle orifice 0.07 in. in diameter. The air is admitted around each burner and is controlled by sets of vanes located around the circumference of drums at the front end of the firebox. Sets of stationary blades with warped surfaces give the entering air a rotating and whirling motion at high velocity, thereby increasing the efficiency of atomization and giving better combustion. The draft is natural, being supplied by a 600-ft. stack. As a maximum only about ½ in. of draft is used and this is regulated by a damper in the uptake. Both this damper and the vanes in front of the boiler are so balanced and arranged that in case of a back fire within the fire chamber, the uptake damper will open wide and the front vanes will close, throwing the force of the explosion up the chimney and not into the boiler room.

The oil is delivered to the storage tanks by large tank trucks, each having a capacity of 1,800 gal. These trucks are equipped with pumps for unloading the oil, which can be done from either side. Connection is made by means of a flexible hose to the inlet pipe of the filling box. The 1,800-gal. tank can be unloaded by this system in approximately ten minutes. This oil-burning installation carries extra precautions, much above those ordinarily required, in order to provide safety. While this was the first consideration, it was found that such a safety installation could be made without loss of efficiency. The flexible layout of piping and connections affords every facility for continuous operation and proper care. The result has been that this plant has operated continuously with no interruption due to faulty installation or imperfect precautions.

SINGER BUILDING BOILER-ROOM INSTRUCTIONS

8 A.M. to 4 P.M.

The Fireman, when coming on watch, must first blow down his gage glass and water-column connections, and not depend too much on feed-water regulators and pump governor. He will then see by his oil gage the amount of oil in the tank he is operating from and, if found low, notify the engineer in charge of watch. Next he will examine the suction oil, pre-heat, oil-pressure and draft gages and see that they are carried at the most economic point or as directed. He will examine his furnaces, tubes, atomizers, impellers, grids and register fronts so as to be kept clean at all times. Start hot-water circulating in tanks Saturday morning. Fuel oil and feed pumps to be changed every Sunday.

4 P.M. to 12 P.M.

The Fireman, when first coming on watch, must blow down his gage glass and water-column connections, and not depend too much on feed-water regulators and pump governor. He will then see by his oil gage the amount of oil in the tank he is operating from and, if found low, notify the engineer in charge of watch. Next he will examine the suction oil, pre-heat, oil-pressure and draft gages and see that they are carried at the most economic point or as directed. Then he will examine his furnaces, tubes, atomizers, impellers, grids and register fronts so as to be kept clean at all times. Clean suction and discharge strainers, blow the tubes in all boilers every night, clean outside and back connections every Thursday and Sunday and keep space between the boilers clean. Transfer oil from one tank to another when required, usually on Sunday.

12 P.M. to 8 A.M. Watch

The Fireman, when first coming on watch, must blow down his gage glass and water-column connections, and not depend too much on feed-water regulators and pump governor. He will then see by his oil gage the amount of oil in the tank he is operating from and, if found low, notify the engineer in charge of watch. Next he will examine suction oil, pre-heat, oil-pressure and draft gages and see that they are carried at the most economic point or as directed. He will examine his furnaces, tubes, atomizers, impellers, grids and register fronts so as to be kept clean at all times. Blow the tubes in all boilers. Clean out back and side connections every Thursday and Sunday. Keep between boilers clean.

DON'TS

Don't look into furnaces with fires going without goggles.
Don't start up burners under a boiler without first seeing that there is water in it.
Don't start up burners without first opening the dampers.
Don't keep damper open after all the burners are extinguished, as it is disastrous to brickwork and boiler.
Don't leave oil in drip pans under burners or fuel-oil pumps.
Don't run the temperature of suction oil over 110 deg. F. or under 96 deg. F.
Don't run the temperature of pre-heat oil higher than is necessary for the gravity mentioned on blackboard; it is wasteful.
Don't run excessive draft; it is also wasteful. Use enough to give 14½ per cent CO_2 in furnace.
Don't run with dirty tubes or back connections. It is your duty to keep them clean.
Don't forget to close dusting doors when through blowing tubes.
Don't run with a leaky system; tighten it up.
Don't run at any time with a dirty boiler room or fronts; it is just as easy to be clean.

Note—Follow these instructions. Leave everything at the end of your watch as you expect to find it. Report to your engineer if it is not so.

N. KING,
Chief Engineer.

With oil the plant is operated with two boilers during the day and one at night as against three and two respectively with coal, or with poor coal four boilers during the day. Four men less are required in the boiler-room force, and the saving in disposal of ashes amounts to nearly $3,400 a year. A monthly comparison is maintained between the cost with oil and what it would have been for coal. The latter is arrived at by figuring the cost of coal at current prices and a tonnage based on an evaporation of eight pounds of water per pound of coal, all feed water and steam being metered. To this is added the monthly saving in ash disposal and labor.

On June 1, 1920, the use of fuel oil began officially, and from that date to June 30, 1922, two years and one month, the average saving was 34 per cent better than if we had used No. 2 buckwheat coal ranging in price from $6.75 per ton of 2,000 lb. with 20 per cent ash to $8.70 per ton.

The average efficiency maintained over the period was 78.7 per cent with a furnace and lower tube upkeep of 14/100 of a mill per boiler horsepower for the two years and one month of operation. This includes renewal of the bottom row of tubes at the time of making the change; since then only three tubes have been renewed, in spite of the boilers being 15 years old and containing the original tubes, with the exceptions noted. These are commercial figures and not test conditions. Moreover, the tubes are clean and free from oil on the outside. The saving in dollars and cents follows:

June, 1920, to December, 1920	$18,669.99
January, 1921, to December, 1921	$28,437.93
January, 1922, to June, 1922	$10,922.65

This saving represents the total cost of installation plus 12.2 per cent interest on the investment, or stated differently, the installation paid for itself in 21 months, since which it has shown a saving of 34 per cent over coal. The layout and detail of this installation was by the plant engineers assisted by the drafting department of the Texas Company.

Effect of Superheated Steam on Cylinder Lubrication

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Co.

STEAM cylinders using superheated steam have come to be regarded by many engineers as being particularly difficult to lubricate. When superheat was first used, many considered it necessary to get the highest-flash point and highest viscosity oils that could be found. It was thought that the high temperatures would burn up a low-flash oil so rapidly that it could not remain on the cylinder wall long enough to do any good. It was also claimed that the high temperature would thin the oil down to a point where it would not prevent wear of the cylinder. Furthermore, it was believed that a compounded oil, such as was used for the lubrication of cylinders using saturated steam, would be very undesirable on account of carbonization or decomposition.

On this basis, a straight mineral oil of high flash point and high viscosity was tried out. In some places it worked all right, but in many others it did not work out so well. Deposits were found in the cylinder counterbore, in the valve chest and on the piston rings. Valve seats became cut and worn, pistons leaked and the engine went to pieces generally. Some of the trouble no doubt was caused by the use of unsuitable metals and improper design.

Carbon Deposits

There seems to be comparatively few complaints of serious cylinder wear, although there have been some. There are a good many more cases of worn valves and valve seats. The most serious trouble, however, seems to be the formation of deposits.

These deposits, consisting of oil and carbon, together with particles of metal, boiler compounds, scale, etc., frequently build up to the point where they interfere with the operation of the valves. Bits of the deposit are broken off and, when carried under the valve, score the valve seat, causing it to leak. The same thing may happen with the piston. The question seems to be, What causes the deposits and how may they be prevented?

Before attempting to answer this question, let us go back and consider the general cylinder conditions. The average so-called superheated-steam engine installation receives steam from the boilers at pressures ranging from 150 to 175 lb. and a degree of superheat amounting to 75 to 100 deg. F. at the boiler. By the time the steam reaches the engine it has lost a good bit of its superheat, and after passing through the valves on its way to the cylinder it has lost a good bit more, so that when it actually enters the cylinder it carries very little superheat at all, and this is entirely disposed of shortly after expansion starts. Throughout the remainder of the expansion stroke, the cylinder wall is in direct contact with steam which is increasing in moisture content, and during the entire period of the exhaust stroke wet steam is in continuous contact with the oil film on the cylinder wall.

Oil for Superheated Steam

Such conditions differ very little from the ordinary steam-engine cylinder conditions, except for the quantity of moisture present, and the same sort of oil should be used for both cases. The usual type of superheat cylinder oil—high-viscosity, straight mineral oil, containing no compounding—is obviously quite unsuitable for maintaining a lubricating film under these conditions. It is too viscous to atomize properly at the operating temperatures, and it cannot adhere to the cylinder wall because of the moisture.

On the other hand, when a medium-viscosity, compounded cylinder oil is used, such as would ordinarily be recommended for wet-steam conditions at the same pressures, no trouble whatever is experienced.

With steam at 150 lb. gage and cut-off taking place at about one-quarter stroke, it has been estimated that, in order for there to be any superheat in the exhaust steam, approximately 200 deg. superheat is required at the throttle. At all degrees of superheat below this,

on the exhaust stroke at least, we have to contend with moist steam, which always requires the use of a compounded oil or in its place the use of an excessive quantity of straight mineral oil, and even then lubrication is quite likely to be unsatisfactory.

Serious trouble from carbonization of the oil has been experienced in engines operating at high steam pressures and high degrees of superheat, most of it being due to an entire disregard for the presence of moisture in the cylinder. When a straight mineral oil of high viscosity is used, similar to practically all so-called superheat cylinder oils the influence of the moisture cannot be counteracted. The engineer observes that he is not getting proper lubrication and increases the feed of oil in an attempt to take care of it. The high-viscosity oil usually has a very low volatility and does not evaporate very quickly. When the large quantities supplied in the engineer's attempt to get lubrication are greater than can be atomized or evaporated, the oil will collect in a liquid state in any portion of the valve chest or cylinder where a depression exists. This pool of oil, subjected to the high temperature of the steam, slowly carbonizes, and as soon as the deposit is built up high enough, bits are broken off and carried under the valves, causing them to wear.

Possibly the engineer observes that the valve is sticking, and thinking it due to lack of lubrication, increases the quantity of oil still further. This in turn aggravates the condition. The friction due to the wearing of the valve seat increases the temperature of the valve, and the latter sooner or later gets so hot that no oil can stay on it at all without carbonizing.

Securing Correct Lubrication

All of this trouble can be eliminated by providing for thorough atomization and evaporation of the oil as soon as it has done its work of lubrication. If a slight percentage of compounding, such as two or three per cent (five per cent won't hurt), be added to the oil to take care of the lubrication of the cylinder on the exhaust stroke, the quantity of oil fed can be greatly reduced. As soon as the quantity supplied is reduced to the point where perfect atomization follows, there will be no opportunity for pools of oil to collect and there will then be no carbonizing.

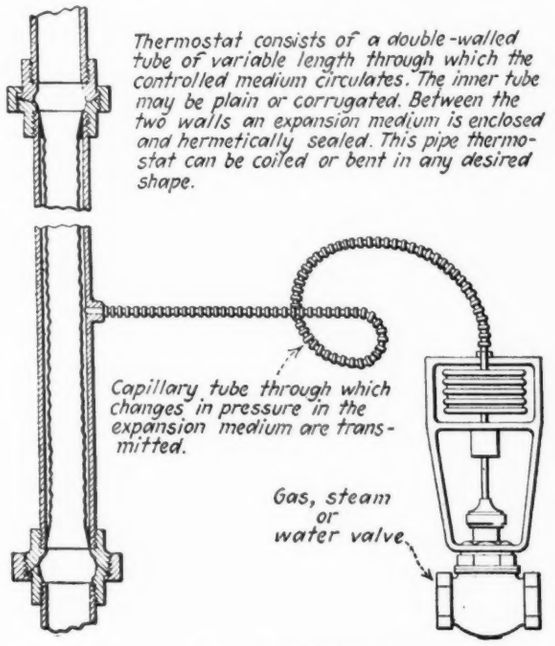
Instead of using the highest possible viscosity, let us use a medium-bodied oil, one that will atomize readily and, having been properly atomized, will provide proper lubrication for the cylinder. Having selected the proper viscosity, let us add from 3 to 5 per cent of compounding to take care of the moisture.

Of course when extremely high temperatures are encountered, as 250 lb. pressure and 200 deg. of superheat, the viscosity must be increased and the boiling point of the oil raised in order to prevent such a rapid evaporation of the oil that it will not adhere to the cylinder wall long enough to lubricate.

New Form of Temperature Regulator

A pipe thermostat has been designed for use in certain applications in which some disadvantages may be found in the operation of the usual tubular type of thermostat. For example, it is often necessary to locate the tubular thermostat in an outside pipe or a special chamber when it is impossible to insert it directly into the heater, tank or other receptacle.

The thermostat shown here consists of a double-walled tube of any convenient length, the inner part being shown corrugated, although it may be plain if desired. The space between the inner and outer tubes is filled with the expansion medium, which may be either a sensitive oil or a volatile fluid, such as ether; the liquid or gas being controlled passes through the inside tube. The temperature of the expansion medium, therefore, follows closely that of the liquid or gas inside the tube. Any change in temperature causes a change in pressure of the expansion medium, which is communicated through the capillary tube into the usual form of expansion element. The latter is a short piece of thin corrugated tubing, which is shortened or lengthened by changes in pressure of the liquid inside of it; the upper end is fixed, and the lower end is fastened to the valve stem. Thus an increase in temperature of the liquid or gas in the inside tube raises the temperature of the expansion medium, and therefore its pressure, lengthens the expansion element and pushes down the valve stem.


Thermostat consists of a double-walled tube of variable length through which the controlled medium circulates. The inner tube may be plain or corrugated. Between the two walls an expansion medium is enclosed and hermetically sealed. This pipe thermostat can be coiled or bent in any desired shape.
Capillary tube through which changes in pressure in the expansion medium are transmitted.
Gas, steam or water valve.

PIPE THERMOSTAT

The jacketed pipe-section does not interfere in any way with the flow of the fluid whose temperature is being controlled.

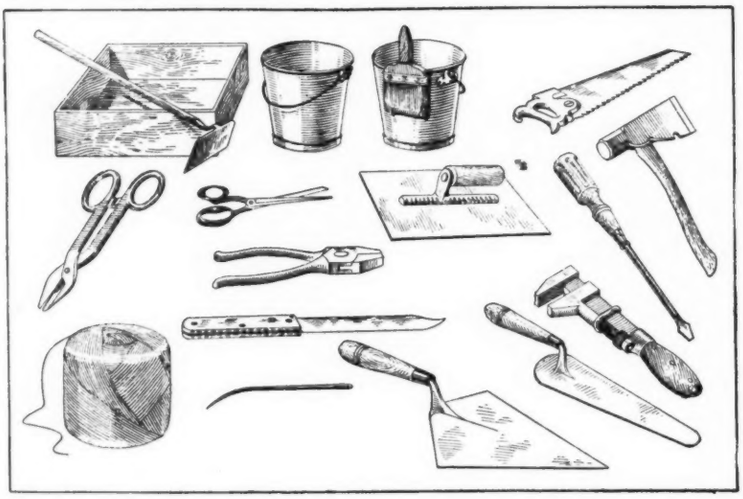
Two advantages of this arrangement are that the controlled liquid or gas has a free passage, not interfered with in any way by the thermostat, and that the sensitiveness of the device can be greatly increased by lengthening the double-walled tube. This would not be likely to cause any inconvenience in setting up the piping, because the thermosensitive tube may be coiled or bent as desired.

The device has been patented by H. J. C. Wells, 620 Riverside Drive, New York City. Mr. Wells suggests a number of applications, such as the equipment of certain heaters for liquids simply by substituting the thermosensitive tube for the exit pipe, the use of the device for controlling the cooling-water systems of air compressors and gas and oil engines, and also for humidity and temperature control of dry kilns, the air from the kiln being drawn through the thermosensitive tube, which may be placed outside the kiln.

How To Apply Heat Insulation

By P. W. Swain,
Associate Editor *Power*

Practical Instructions for Insulating Piping, Bends, Tees, Ells and Other Heated Surfaces With 85 Per Cent Magnesia



MOST operating engineers have some idea of how to go to work to insulate piping, fittings, etc., with 85 per cent magnesia. As a rule their knowledge has been gained by trying their hand at small repairs or by watching the work of professional pipe-covering mechanics. But there are certain methods of doing things and certain "tricks of the trade" that must be learned if the job is to be done quickly and well. While there is no "one way" of performing each operation, this article presents methods that are used by the majority of practical mechanics in this line.

It is not the purpose of this article to recommend that operating engineers make a practice of doing their own pipe-covering work. It is usually cheapest and best on large jobs to have the work done by contract. At the same time it frequently happens that small additions or changes are made in the piping that necessitate a little work of this sort and yet are not large enough to warrant calling in a contractor. With a little care such jobs can be well handled by the men in the plant, while, on the large contract jobs, a practical knowledge of covering will be of great help to the engineer in preparing the specifications and inspecting the work.

The pages that follow contain specific instructions for the various operations, so it is only necessary to give some general information on this page.

General Instructions

Eighty-five per cent magnesia, as the name indicates, contains about 85 per cent of carbonate of magnesia, an extremely light white substance of high insulating value. This is mixed with about 15 per cent of asbestos fiber to give it strength.

Covering for pipes up to about 10-in. nominal size is ordinarily made in two half-sections encircled with canvas. The standard section is 3 ft. long. Three feet is also the standard length for blocks, which are ordinarily 6 in. wide. Pipe covering comes in several thicknesses—standard (about 1 in.), double standard (two standard-thick layers), 1½ in., 2 in. and 3 in. (two 1½-in. layers)—while blocks can be obtained of any desired thickness and curvature. The manufacturers are always ready to give information as to the correct form, thickness and amount of the materials needed. All they require is a list of the piping and fittings to be covered and a statement of the steam pressure or temperature carried. The manufacturers can also estimate the amount of magnesia cement, wire, extra canvas, etc., needed for the job.

Magnesia cement is nothing but 85 per cent magnesia in powdered form. This is mixed up with water to an easily workable consistency and applied with a trowel. When it hardens it is exactly the same material as blocks or pipe covering. In covering large fittings, it is frequently possible to wire on scraps of pipe covering or blocks before applying the cement. This saves material and time, and makes just as good a job, because the cement forms a perfect bond with the scrap. The cement shrinks on drying, so it should be applied in thin layers (about ¼ in.). Allow each layer to dry before applying the next. The shrinkage cracks do no harm if filled by the next layer. Wet cement will not stick well to hot metal. Wherever it is necessary to apply the cement directly to metal, it is well to start by dabbing on small amounts here and there.

Paste for canvas may be made by stirring up two or three handfuls of starch in a pail of boiling water (heated by blowing in steam), but a special cold-water paste is available for this work and is usually preferred by pipe-covering mechanics.

The following tools and equipment, which are pictured at the top of this page, are commonly used in the application of 85 per cent magnesia insulation: Box and hoe for mixing cement, cement pail, paste pail and brush, crosscut saw for cutting up pipe covering and blocks, snips for cutting cable, shears for canvas, side-cutting pliers for wire, trowels (pointing, English and smoothing) for applying cement, butcher knife and lather's axe for trimming blocks and pipe covering, sailmaker's needle and sewing twine for sewing canvas on special jobs, monkey wrench and screwdriver for odd jobs. In addition to the equipment mentioned, most of which is to be found in every power plant, ladders, horses and scaffolding are needed according to the location of the work.

The writer wishes to acknowledge valuable suggestions received from E. C. Nankervis, Eastern district superintendent for Keasbey & Mattison Co., and from F. F. Cooper, superintendent of the Contract Department of Chas. S. Wood & Co., Newark, N. J.

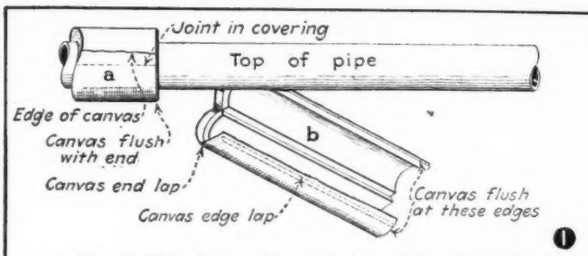


Fig. 1—The figure shows the top view of a pipe, the left side of which is already covered, *a* being the right-hand end of the last section applied. Take up the next section *b* and swing it open on its canvas hinge with the opening up and the end of the section with the canvas end lap at the left. Slip the section over the pipe in this position and close it like a book.

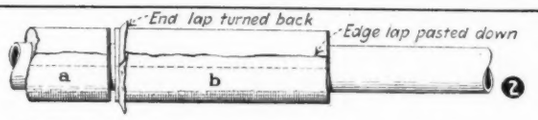


Fig. 2—Paste down the lap along the lengthwise joint, using starch paste or cold-water paste. Meanwhile leave the end lap turned back as shown.

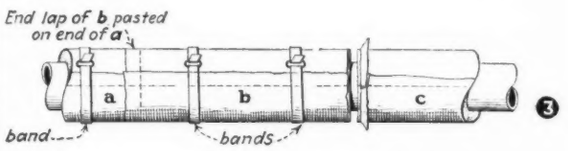


Fig. 3—The lap at the left end of section *b* is now pasted down over the right end of section *a*. Section *c* is shown in the same position as was section *b* in Fig. 2. Bands are shown applied to the completed covering up to the end of *c*. If the pipe covering is painted, this should be done before the bands are applied. Ordinarily, two bands, placed about 18 in. apart, are used per section.

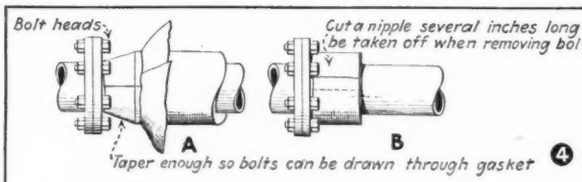

Bolt heads
Cut a nipple several inches long to be taken off when removing bolts
A
B
Taper enough so bolts can be drawn through gasket
4

Fig. 4—*A* shows one way to allow for bolt removal at flanges. After peeling back the canvas, the end of the section is cut to a long taper (with a butcher knife). Then the canvas is pasted back. Where it is not practicable to allow for complete removal of the bolts, the taper on the covering should at least allow the bolts to be pulled through the gasket. *B* shows another method. A nipple (a little longer than the bolts) is sawed from the end of a section of pipe covering and placed next to the flange. This nipple can easily be removed and replaced.

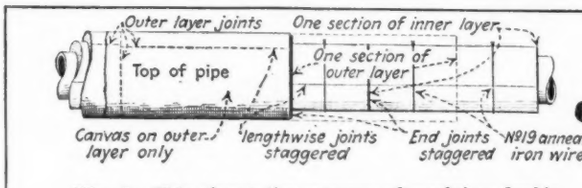


Fig. 5—This shows the manner of applying double-thick sectional covering. Here the outer layer is just like the single-layer pipe covering already shown, and is applied in exactly the same manner. The inner layer, having no canvas, must be wired onto the pipe as indicated. The outer layer is placed over the inner in such a way as to stagger or "break" both the circular and lengthwise joints. This avoids the possibility of any cracks leading directly through the covering.

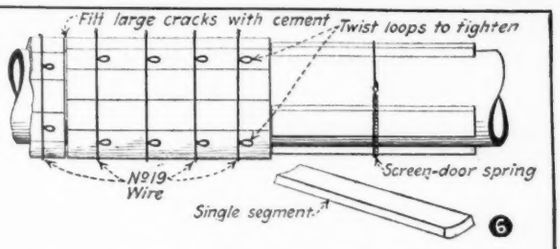
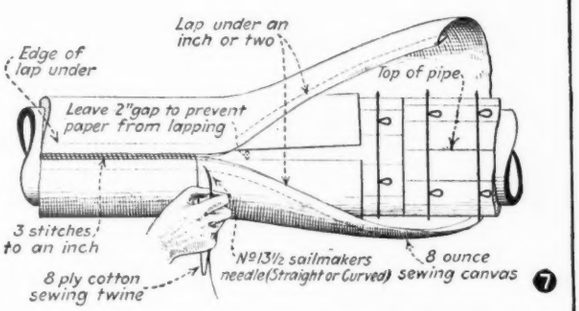


Fig. 6—For pipes larger than 10 in. the covering usually comes in curved segments, 6 in. or less in width. These must be wired in place, as shown at the left. The right shows another section being started. After all the blocks are in, put on four wires in the position shown and twist the ends slightly with the pliers. The wires are tightened by twisting large loops at various points, while beating the blocks down with a wooden paddle to take up the slack. After the blocks are wired in place, fill the cracks and cover the wires with magnesia cement before pasting on the canvas.

Fig. 7—On particularly high-class jobs it is sometimes worth while to finish off pipe covering with heavy (8 or 10 oz. to the square yard) canvas, sewed together over the pipe covering. The figure shows the application of such canvas to the pipe covering of Fig. 6. For this work there are needed a long strip of canvas cut to a width 2 or 3 in. greater than the circumference of the covering and strips (roll width) of rosin-sized sheathing paper cut to lengths about


Lap under an inch or two
Edge of lap under
Top of pipe
Leave 2"gap to prevent paper from lapping
3 stitches to an inch
№13½ sailmakers needle(Straight or Curved)
8 ounce sewing canvas
8 ply cotton sewing twine
7

2 in. less than the circumference of the covering, so that the ends will not meet when wrapped around. The sewing is done with a No. 13½ curved or straight sailmaker's needle and some eight-ply cotton sewing twine rubbed with beeswax. The paper is put on first, as shown, to give a smooth surface. The gap presents an unsightly lap, and should be on top of the pipe and directly under the seam. Turn each edge of canvas under 1 in. or more as shown. Sew over and under as indicated, using about three stitches to the inch. The folded edges of the canvas should be slightly apart before sewing to allow the stitch to pull the canvas tightly into place.

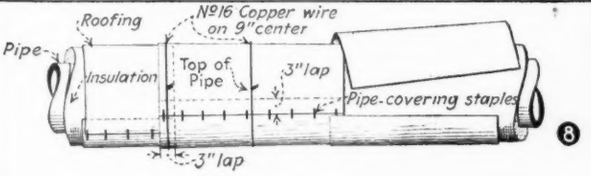


Fig. 8—One way to waterproof the covering of a line exposed to the weather is to paint the canvas with asphaltum paint. This is particularly desirable for fittings. On straight piping it is probably better to use good sheet roofing, one, two or three-ply. While three-ply is the most durable, one- or two-ply, being thinner, makes a more workmanlike job on the laps. The method of application is clear from the drawing. The longitudinal laps may be staggered, as shown, or placed in line. In order to shed the rain and at the same time be out of sight, they are located a little down from the top. The outside part of the lap should, of course, point downward. All laps and staples should be painted with roofing cement.

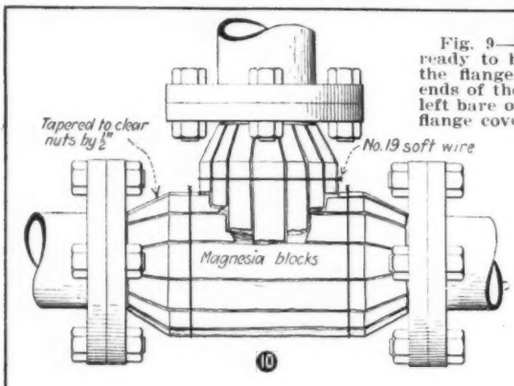


Fig. 9—This shows a large flanged tee ready to be covered. In the case shown, the flanges, as indicated by the tapered ends of the pipe covering, are either to be left bare or to be provided with removable flange covers (see last page).

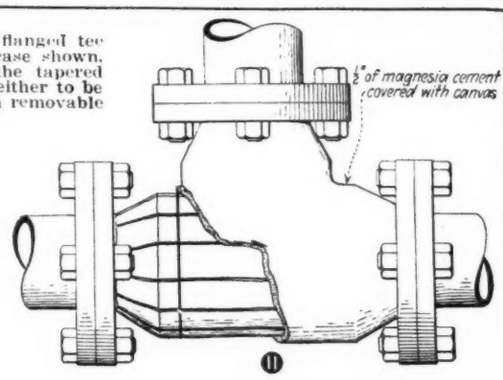


Fig. 10—The first step in covering this tee is to wire on blocks as shown. The appearance of the job at this stage is of little importance. In fact, it is good economy and makes just as good a job to use up any scraps of pipe covering or blocks that may be lying around. A short-cut way of covering tees is to use a section of pipe covering that will just fit the run of the tee. A hole is cut for the outlet. Before applying, it is best to remove the canvas. The two half-sections can then be wired in place, after which cement can be used to fill the cracks and to cover the exposed portion of the branch of the tee. After that, the canvas is pasted in place again. Small screwed fittings are often covered directly with cement without using any blocks or pieces of scrap. In such a case, two or three pieces of wire wrapped loosely around the fitting will help to hold the cement in place. If the fitting is hot, the cement will not stick well while soft. In that case the job can be done, if necessary, by first wiring on a layer of burlap soaked in paste. A thin coat of cement is applied to this and allowed to dry before applying the next coat.

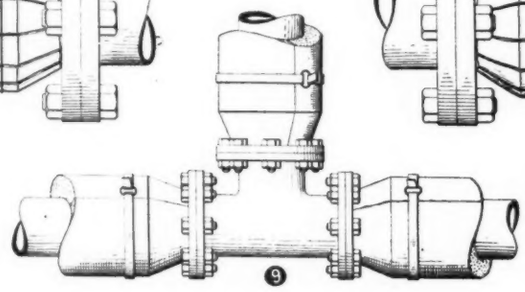
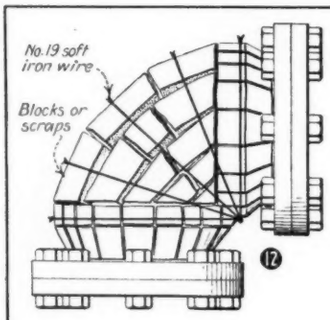
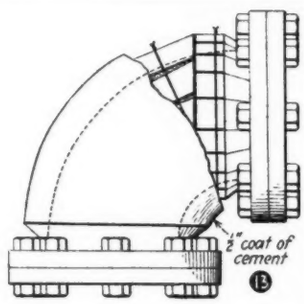


Fig. 11—Fill the cracks and cover the blocks with magnesia cement to a depth of about ¼ in. Let this coat dry. Then fill the shrinkage cracks and finish off to a total thickness of about ⅛ in. of cement. Finish by pasting on the canvas cover.





Figs. 12 and 13—These figures show how to cover an ell. The principle is the same as with a tee, but the double curvature of the surface makes it necessary to use smaller blocks or pieces of scrap. These should be mashed down to fit the curvature roughly, and wired tightly in place with several wires before the cement is applied. After the method of covering tees and ells has been mastered, the same principles can be applied without difficulty to other fittings and to valves.

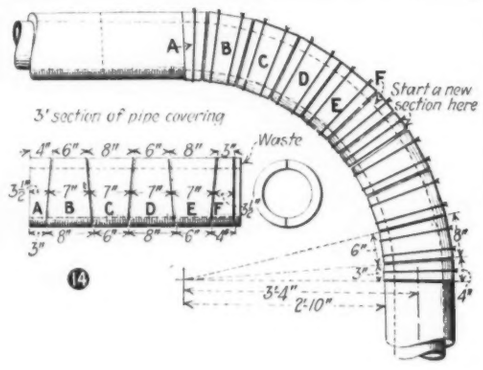


Fig. 14—To make a good job of covering a pipe bend requires practice. The method shown involves a certain amount of measurement. Most experienced pipe coverers would cut the segments shown by eye rather than by measurement, but it will do no harm to measure for the first job. The first step is to saw a section of pipe covering up into a number of short wedge-shaped nipples. These should be short enough to make a fairly smooth curve when wired onto the bend in the manner shown. The drawing shows how to saw the covering by measurement where the bend has a radius of curvature of 40 in. to the center of the pipe and where the outside diameter of the pipe covering is 12 in. It is then 34 in. from the center of curvature to the near side of the pipe covering and 46 in. to the far side. For segments 6 in. wide on the narrow edge, the width at the other edge can be determined by taking a large sheet of wrapping paper and drawing two lines from a point in such a way that they are 6 in. apart when 34 in. from the point. Continue the lines to 46 in. and see how far they are apart. This gives the outside width (8 in. in this case).

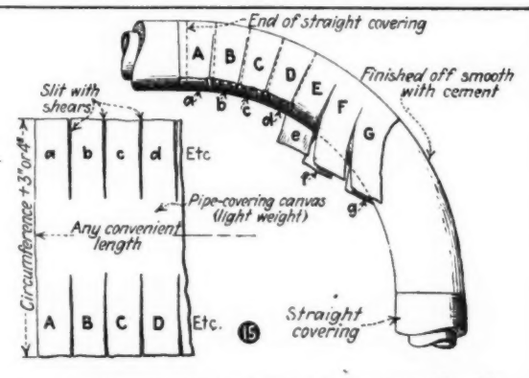
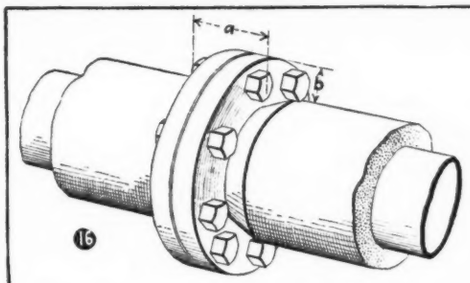


Fig. 15—Cementing the bend requires considerable care to get a neat job, because magnesia cement does not act like ordinary plaster under the trowel. It is best to apply each dab of cement with a single stroke of the trowel and not to go over it again except to add more cement or to cut it off where too much has been added by mistake. While experts can stretch thin canvas onto a bend without wrinkles, it is easier to split the canvas with shears, as shown. This method of application allows for the fact that the length of covering is less along the inner arc of the bend.



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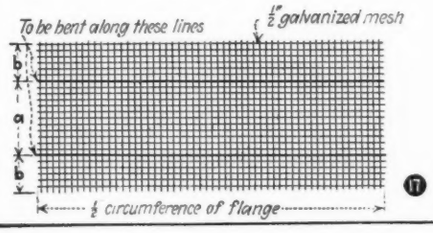

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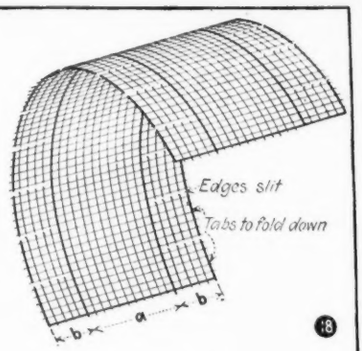
Fig. 16—This shows a flange which is to be provided with a removable flange cover.

Fig. 17—The first step is to cut a strip of ½-in. mesh hardware cloth to the dimensions shown.

Fig. 18—Then bend this strip into a half-circle and split both edges at frequent intervals to the indicated depth.

Fig. 19—Bend down the tabs on the edges. For extra strength in handling it may help to weave a wire around the edges through the tabs.

Fig. 20—Magnesia blocks two or three inches wide and 1 in. or 1½ in. thick are sawed into pieces as long as the framework is wide, and wired on as indicated. After the blocks are in place, cement is applied in the usual manner. When two such halves are made, they are covered with canvas and provided with a canvas hinge at one end. Such a cover is easily put on the flange or taken off, but the construction is so expensive that many engineers prefer to plaster cement directly on the flanges and destroy the covering when necessary to get at the bolts.



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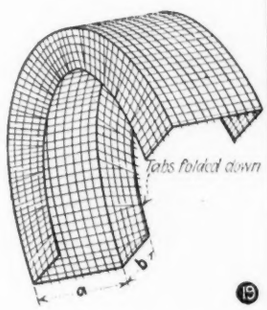

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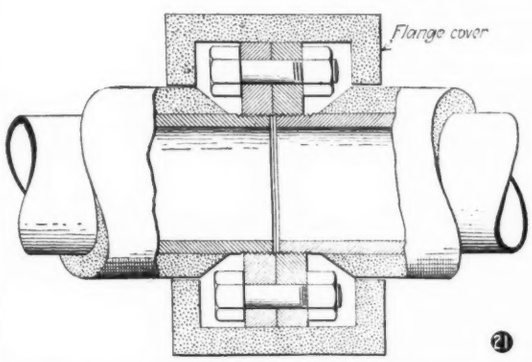
Fig. 21—This cross-section shows the finished removable flange cover in place. It is held together by heavy wire or pipe-covering bands wrapped around it.



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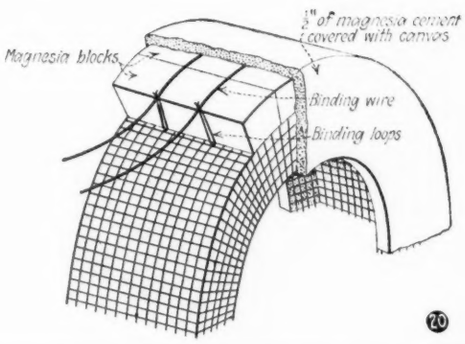

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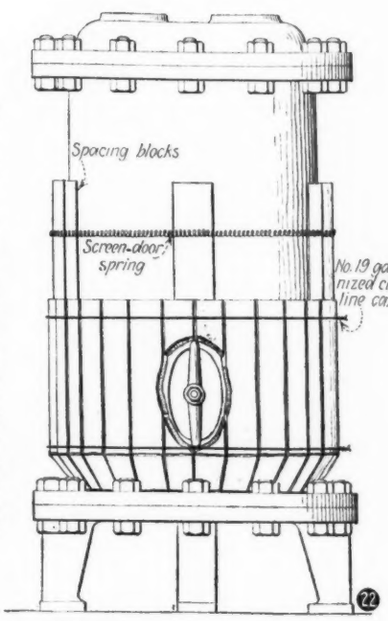
Fig. 22—This illustrates the method of covering a heater. The bottom course of blocks is shown bound in place with light cable. No. 19 wire is not strong enough for this work, while heavier wire tends to break when twisted. In the figure the second course is just being started, with the aid of a screen-door spring to hold the blocks until they are wired.

Fig. 23—After all the blocks are in place, the cracks are filled with magnesia cement, and the heater is wrapped with a layer of 1-in. mesh chicken netting, wired tightly in place. This serves as a reinforcement for the cement that follows. The job may then be finished with a half-inch layer of magnesia cement, over which canvas is pasted, or the canvas may be done away with by applying a half-inch coat of hard-finish asbestos cement directly to the blocks or over magnesia cement. The hard-finish cement is a mixture of asbestos cement and Portland cement, and may be purchased ready mixed. It has little insulating value, but forms a hard, smooth and durable finish. Boiler drums and similar large surfaces are covered according to the same general scheme. In all cases it is important to anchor the blocks securely with cable or wire mesh.



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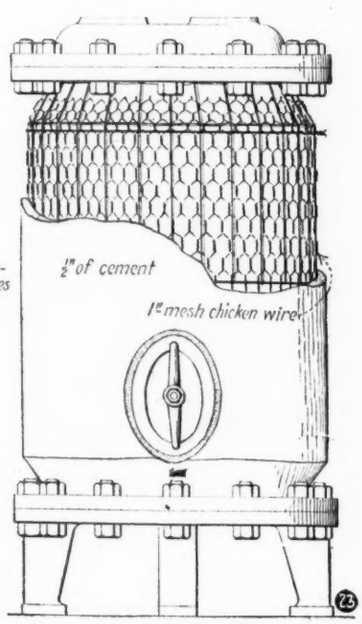


23

Power Plant of the Duratex Company Has Many Interesting Features

THIS plant of 625-kva. capacity has one boiler of 3,330 sq. ft. of heating surface and one turbo-generator A second set of units is to be installed. For its size and the kind of load supplied, the plant is extremely simple in its design, all important equipment being located on the boiler-room and turbine-room floor level. The boiler is operated up to 350 per cent of its normal rating, is fired by an automatic stoker and the coal is weighed in a weighing larry. Provisions have been made so that operation is largely automatic, and the records of plant performance are secured to a large degree by recording meters.

TOO much equipment is a criticism that can be made of many industrial power plants. It is not uncommon to find plants equipped with a multiplicity of small hand-fired boilers and a lot of small prime movers. To obtain an intelligent record of such a plant's operation would generally cost more than the saving in operating expenses. Instead of using a number of small-sized units the load could be more efficiently handled with a minimum of larger-sized ones. This would also make it economical to equip the plant to obtain an intelligent record of its operation.

When the Duratex Co., Newark, N. J., which manufactures imitation leather and rubber cloth, decided to enlarge its manufacturing facilities to include a complete rubber-manufacturing plant, the consulting engineers kept the foregoing facts constantly in mind. One of the decisions made was that the power plant should be as simple as it was possible to make it and yet meet the company's heating and power needs. Previous to the enlargement of the plant, power was purchased from the local central-station company and steam for process work and heating was supplied from two hand-fired horizontal-return fire-tube boilers, each of 2,000 sq.ft. of heating surface and operated at 100 lb. gage pressure. At the time the work was laid out, the company was able to purchase only such power as could be supplied by feeders and transformers, having a capacity of 200 kw. To drive the rubber-manufacturing equipment, it was necessary to use a total of about 1,100 connected horsepower. In addition to this about 400 connected horsepower was required for the other departments of the plant. As the power company was unable to supply more power, it was decided to increase the size of the power plant. After an engineering study by Wood, Hulse, Yates Co., consulting engineers, in conjunction with R. De V. Hope, works manager for the company, it was found that a new plant would be more economical than an extension to the old one, and it was decided to make this plant as simple as possible. A study of the low-pressure steam requirements for heating and process work showed that the demand would probably reach as high as 10,000,000 lb. per month during the winter. Under the old conditions steam was supplied to the processes at from boiler pressure (100 lb. gage) to 15 lb. gage; pressures at less than 100 lb. being obtained through reducing valves. Changes were made so that steam at 15 to 20 lb. could be used and the reducing valve set to give this pressure. This arrangement allowed the installation of an exhaust-steam turbine in the new plant. As the problem worked out, it was decided to install two boilers, each

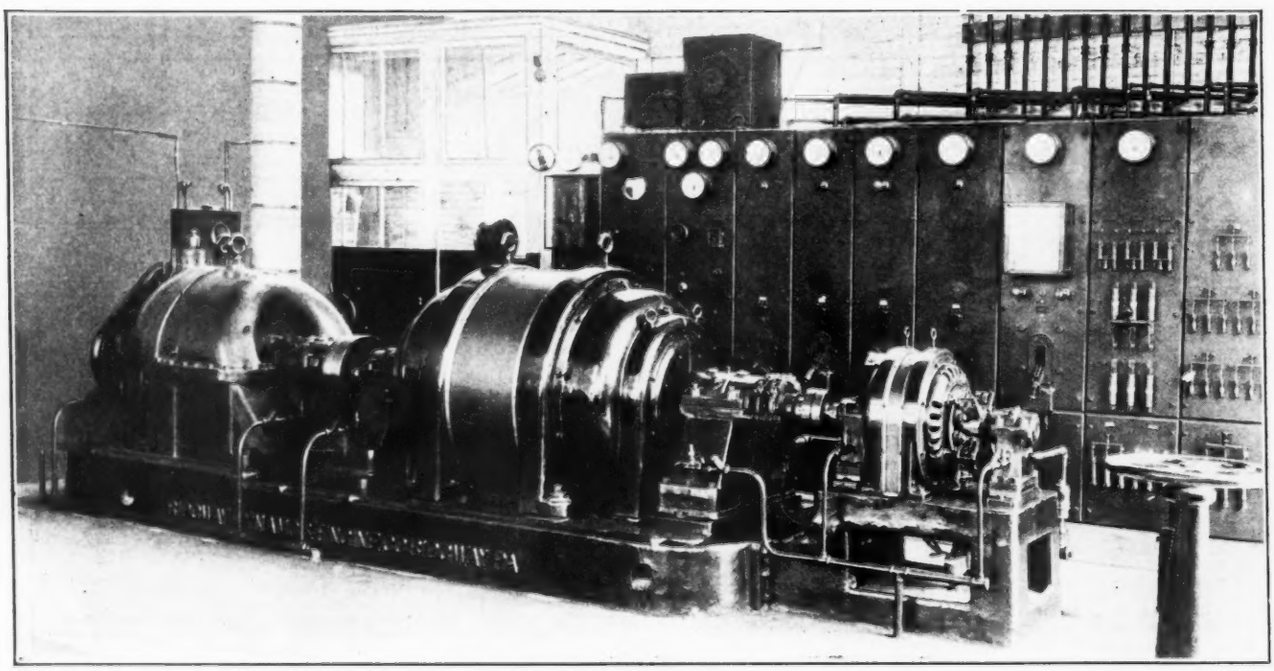
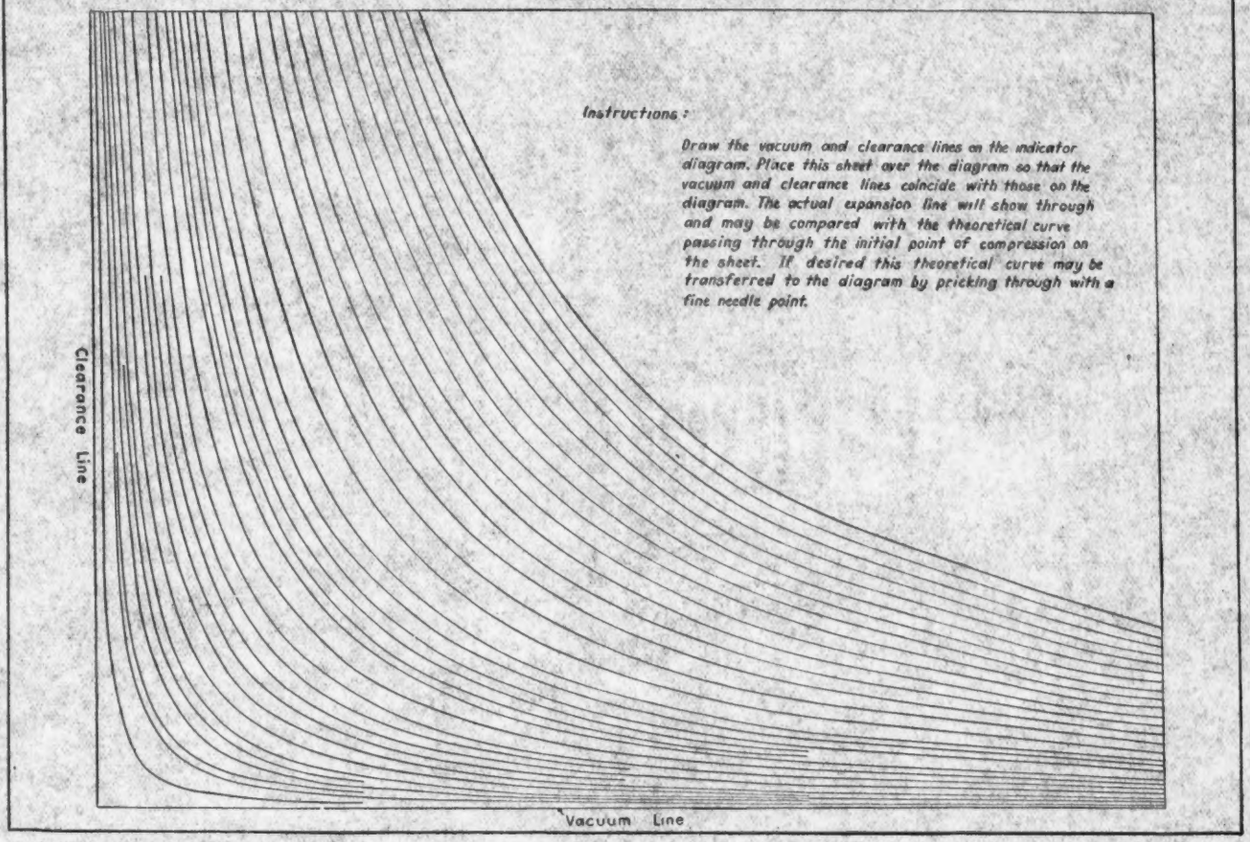
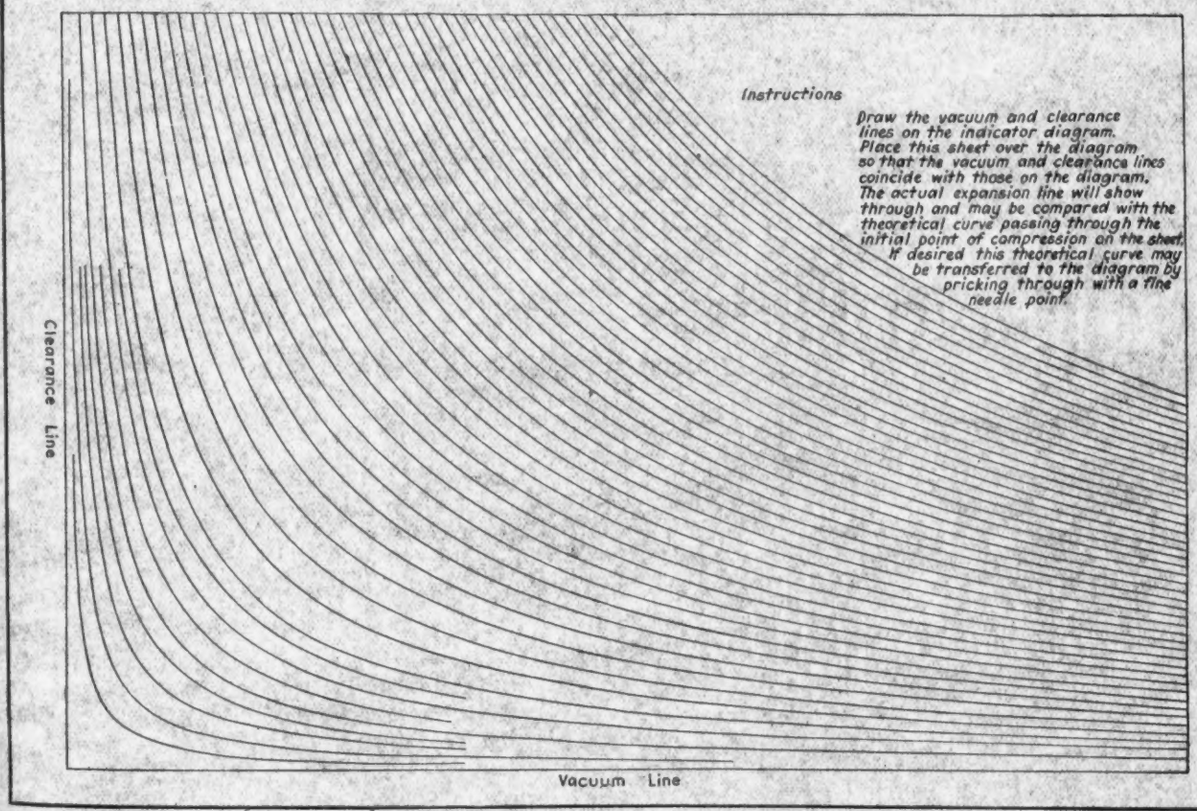


FIG. 1—TURBO GENERATOR OF 625-KVA. CAPACITY OPERATING AT 3,600 R.P.M. AND GENERATES 460-VOLT 3-PHASE 60-CYCLE POWER

ADIABATIC CURVES FOR AMMONIA COMPRESSOR INDICATOR DIAGRAMS


Instructions:
Draw the vacuum and clearance lines on the indicator diagram. Place this sheet over the diagram so that the vacuum and clearance lines coincide with those on the diagram. The actual expansion line will show through and may be compared with the theoretical curve passing through the initial point of compression on the sheet. If desired this theoretical curve may be transferred to the diagram by pricking through with a fine needle point.
Clearance Line
Vacuum Line

ISOTHERMAL CURVES FOR AMMONIA COMPRESSOR INDICATOR DIAGRAMS


Instructions
Draw the vacuum and clearance lines on the indicator diagram. Place this sheet over the diagram so that the vacuum and clearance lines coincide with those on the diagram. The actual expansion line will show through and may be compared with the theoretical curve passing through the initial point of compression on the sheet. If desired this theoretical curve may be transferred to the diagram by pricking through with a fine needle point.
Clearance Line
Vacuum Line

of 3,330 sq.ft. of heating surface, equip them with automatic stokers and put in two 625-kw. turbines to operate on a back pressure of from 15 to 20 lb. gage. Up to the present time only one boiler and one turbo-generator have been installed. The second set of units will be installed at a later date.

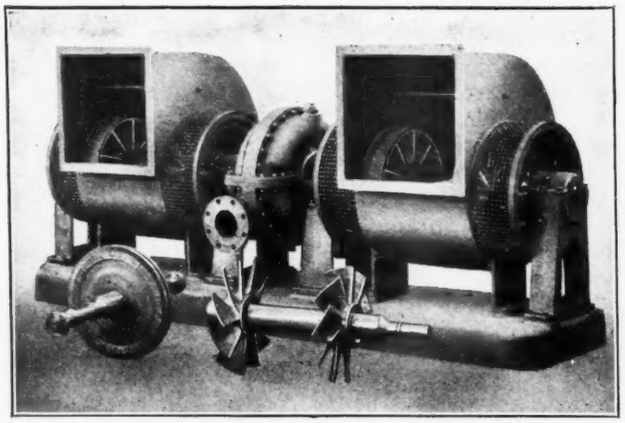


FIG. 2—TYPE OF TURBO-BLOWER USED FOR FORCED AND INDUCED DRAFT

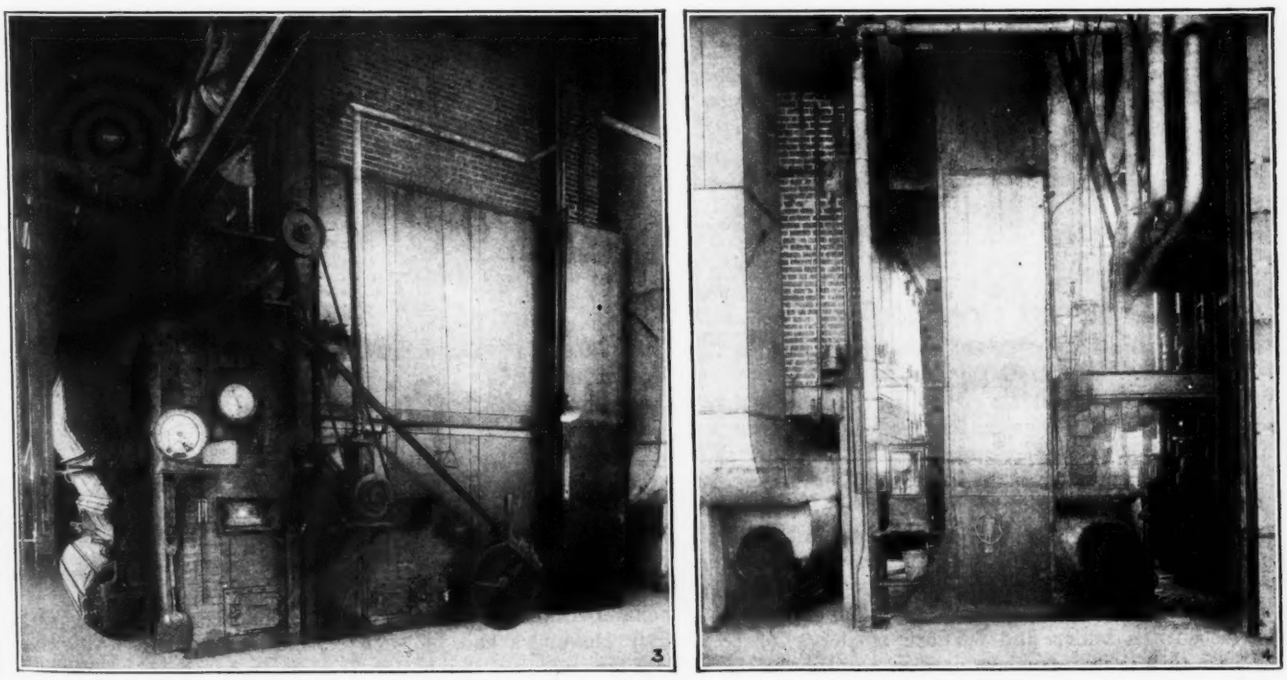
As a result of the investigation made on the exhaust-steam requirements, it was evident that there would be a demand in the process work and heating for all exhaust steam available from the main turbine. This left only the exhaust from the boiler-feed pump, forced-draft and induced-draft fans for feed-water heating, which was only sufficient to increase the temperature to about 120 deg. under normal operation. Two studies were made—one of the cost for a stack having sufficient capacity to take care of two boilers without economizers and induced-draft fans, the other one of the cost of a short stack with induced-draft fans and economizers. These investigations showed that the latter could be installed for considerably less cost than the former. These two factors brought about the installation of the economizer, even though about the lowest-priced coal possible to obtain is used, which at the time the plant was designed was about $5 per ton, delivered on the grate.

In the laying out of the plant effort has been made to obtain an installation having a minimum of equipment, simple and economical in its operation. Since this plant operates non-condensing, it probably has less equipment than any other station in this country of the same capacity and obtaining a similar record of operation. This record has been made practically automatic by the installation of a few recording instruments.

The building is of steel and brick with a reinforced-concrete slab roof. Although there is a basement, practically all the important equipment is on the boiler and turbine room floors, which are on the same level with a brick division wall between them.

Coal may be received by rail or truck and is dumped into a reinforced-concrete track hopper, from which it is carried by a bucket elevator to a 300-ton reinforced-concrete bunker which has storage capacity sufficient for about 15 days' normal operation. Additional coal storage is available along the railway track in proximity to the plant. A one-ton weighing larry, propelled by hand through a gear train, conveys the coal to the stoker hopper. In weighing the coal, all the fireman has to do is to balance the scales and pull a small lever, which registers the weight on a card.

The boiler is a B. & W. inclined-tube type, equipped with a B. & W. superheater designed for 100 deg. of superheat at normal rating of the boiler. An economizer of the B. & W. type, having 994 sq.ft. of water-heating surface, is installed back of the boiler, as indicated in Fig. 5. The economizer is of a new design and consists of horizontal rows of 2-in. by 10-ft. 2-in. steel tubes placed on $3\frac{3}{4}$-in. centers. Starting at the bottom, one end of each horizontal row is connected to one end of the row above by a header, so



FIGS. 3 AND 4—BOILER EQUIPPED WITH CHAIN-GRATE STOKER, FORCED- AND INDUCED-DRAFT FANS AND ECONOMIZER OF NEW DESIGN

that in Fig. 5, if the flow of water is away from the reader in the bottom row of tubes, it will be up through the plane of the paper in the second row, down through the third row and up through the fourth row, etc., until the top is reached, whence the water passes to the boiler. This economizer is arranged on the counter-flow principle. The feed water enters the bottom row of tubes and flows through each consecutive row to the top, where the gases from the boiler enter the top of the economizer and flow downward. This brings the hottest gases in contact with the hottest water and the coldest gases with the coldest water. This was the first omizer was 341 deg.; namely, from 687 to 346, with feed water entering at 120 and leaving at 215 deg.

Draft is obtained by forced- and induced-draft fans, only a short stack being provided. The fans are turbine driven and operate at a maximum speed of 5,000 r.p.m.. The installation of these fans is a rather unusual arrangement. On account of the small dimensions of the fans and turbines (3 ft. 4 in. high by 9 ft. 10 in. long), due to their high speed and design, it has been possible to set them under the rear of the boiler brickwork. This location is clearly indicated in Figs. 4 and 5. The induced-draft fan is of the same type as

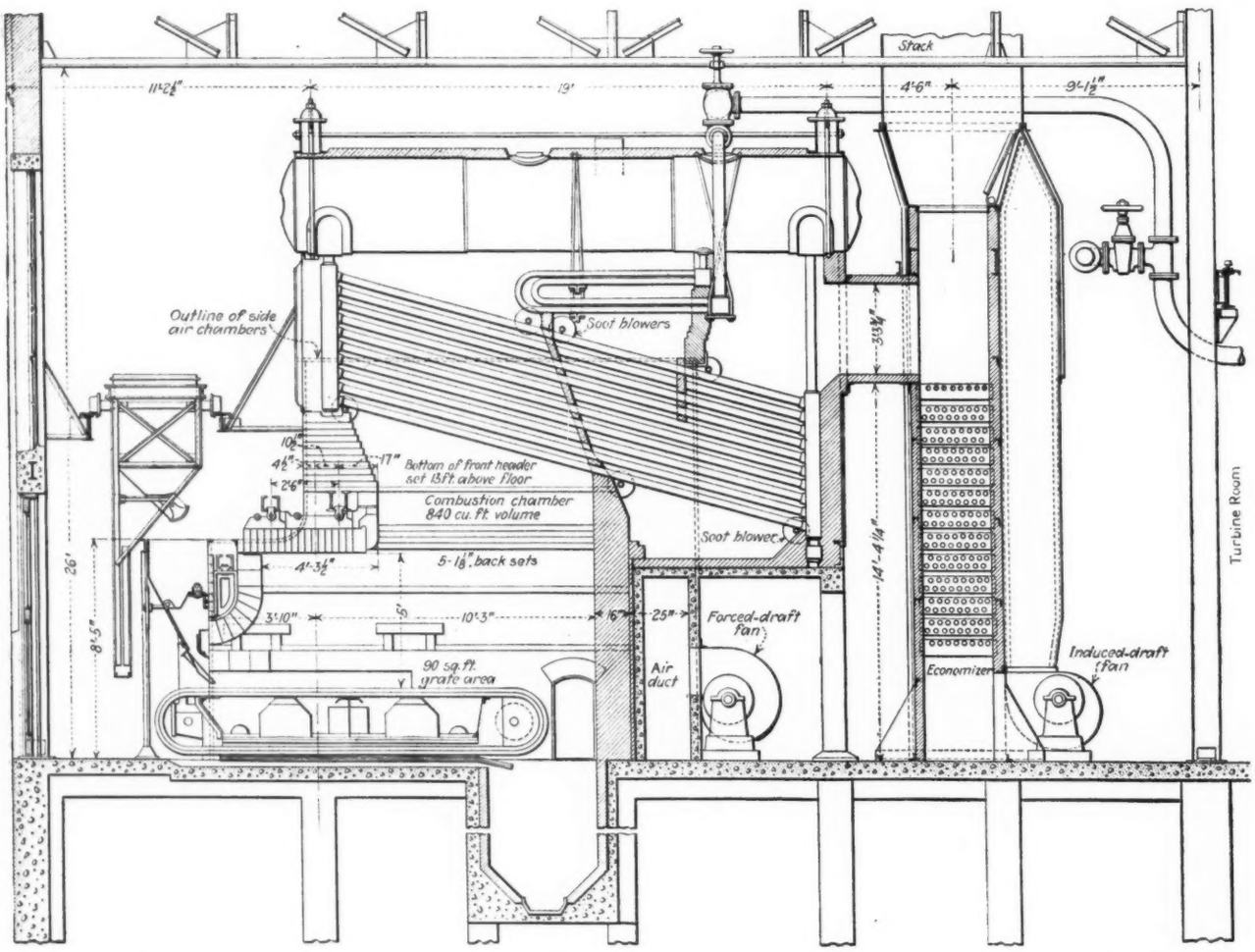


FIG. 5—SECTION THROUGH BOILER AND ECONOMIZER, SHOWING GENERAL ARRANGEMENT OF STOKERS, FORCED- AND INDUCED-DRAFT FANS

installation made of this type of economizer, and for this reason has been called the "Duratex" type.

With the boiler operating at 146 per cent normal rate the temperature of the gases leaving the last pass was 615 deg. F. and at the economizer outlet 298 deg., with the feed water entering at 104 deg. and leaving at 232 deg. Under this condition the over-all boiler and furnace efficiency was 69 per cent, and the over-all efficiency of the boiler, furnace and economizer was 77.22 per cent. At 187 per cent rating, the gas temperatures were 610 and 324 deg., and the feed-water temperatures 132 and 245, with a boiler and furnace efficiency of 68.55 per cent and a boiler, furnace and economizer efficiency of 76.02 per cent. On a series of tests run on the plant the maximum gas-temperature drop through the econ-

that used for force draft and also stands on the boiler-room floor just back of the economizer. A detailed description of these fans appeared in *Power*, Feb. 21 of this year.

To obtain the hottest air in the plant for the furnace, a vertical duct is run up under the roof over the boiler and the air taken from here. This duct is shown in the center between Figs. 3 and 4. After passing through the forced-draft fans, the combustion air goes into a duct along the back of the boiler and into air chambers on each side wall of the furnace. One of these air chambers can be seen extending about two-thirds of the way up the boiler brickwork in Fig. 3. These chambers have a vertical baffle, so that the air passes up over the back half of the brickwork, thence down

over the front half and through the stokers. This results in preheating the air from 30 to 40 deg. F.

A single Coxe, "B" frame, chain-grate stoker fires the boiler. The ignition arch has been made considerably shorter and is set higher than is usually done with this type of stoker. But operation has shown that this setting has not been detrimental to the stokers' operation. The stoker is guaranteed to operate the boiler continuously at 150 per cent normal rating when burning anthracite No. 3 buckwheat. However, the steam-flow meter chart, Fig. 6, shows that the boiler is averaging about 250 per cent rating and frequently goes to 300 per cent and probably much higher, since 300 per cent rating is the meter's limit. Provisions have been made in the hopper so that either anthracite No. 3 buckwheat, or bituminous coal can be fed to the stoker. Where burning bituminous coal, the guaranteed performance is 225 per cent continuously and 300 per cent for four hours.

Part of the steam from the boiler goes, through reducing valves, directly to the processes and for heating, and part to the turbines. The main turbine is rated at 625 kw., runs at 3,600 r.p.m. and operates on a back pressure of 15 to 20 lb. gage. All the exhaust steam is used for heating and in the processes. The machine has four stages and when operating on steam of 150-lb. gage pressure with 75-deg. superheat and exhausting against a back pressure of 15-lb. gage, is guaranteed to produce a kilowatt-hour on 38 lb., at 500-kw. load, which is its best rating.

The alternator is rated at 500 kw. at 80 per cent power factor (625 kva.) and generates three-phase 60-cycle 480-volt current. Excitation is supplied by a 10-kw. 115-volt direct-connected exciter, and the voltage

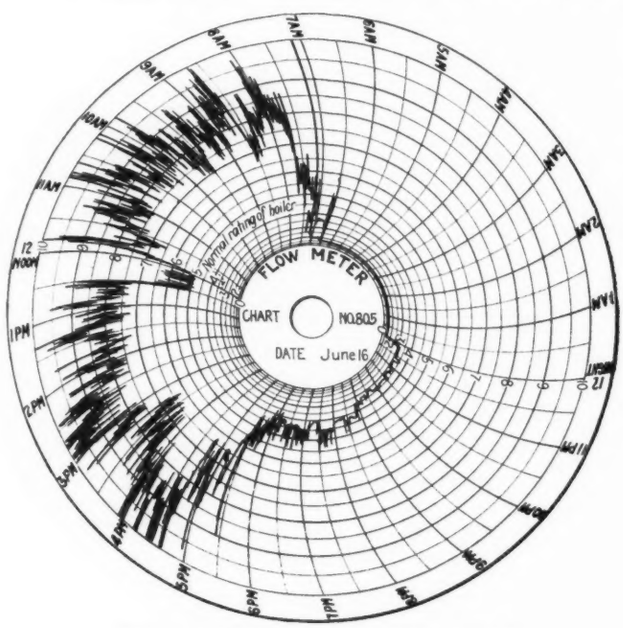


FIG. 6—STEAM-FLOW METER CHART

is maintained constant with a Tirrill regulator. The power that is purchased from the local central-station company is distributed through the plant at 220 volts two phase 60 cycle, and a number of such motors are in operation in the plant. To supply these motors from the alternator, Scott connected transformers are used to change the power from 480-volt three-phase to 220-volt two-phase.

In the rubber mill the calenders are driven by direct-current motors, and to supply them, two 240-volt 165-kw. six-phase rotary converters are installed. On account of the variable characteristics of the load driven by the induction motors, the power factor is low. In designing the rotary converters, they were liberally

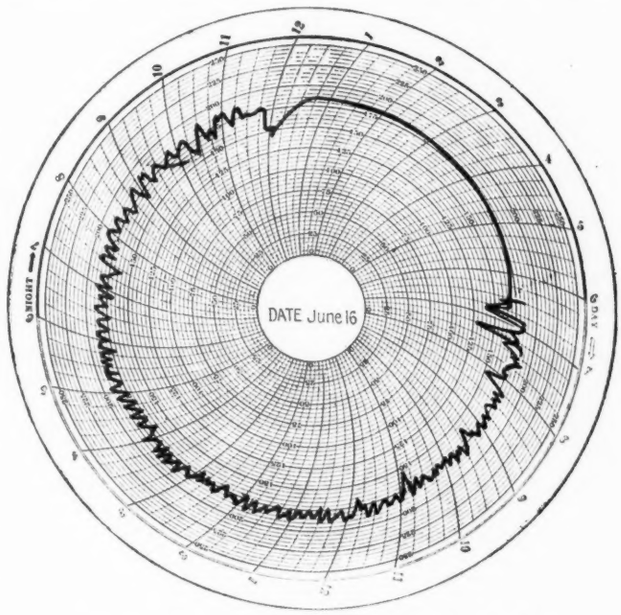


FIG. 7—RECORDING PRESSURE GAGE CHART

rated so that they might also be used for power-factor correction. Before the converters and a synchronous motor driving an air compressor were installed, the power factor of the system was about 50 per cent, but since their installation it has been possible to raise this to about 90 per cent.

As indicated by Fig. 6, the load on the plant fluctuates through wide ranges, at times reaching about 350 per cent rating of the boilers. However, a colored fireman is capable of operating the boiler plant and maintaining the steam pressure as indicated in Fig. 7, which is the pressure chart corresponding to the load in Fig. 6. It should be noted that the regulator, which controls the speed of the forced- and induced-draft fan and stoker, operates on a variation in pressure. For the same day's operation, between 7 p.m. and 4:30 a.m., the average CO_2 was about 15 per cent and very seldom did it drop below 14 per cent. This day's operation was taken care of with coal having a quality not much better than anthracite culm. Since this pressure curve was taken, the regulator connections have been changed so that the pressure is now maintained within the limits of a 5-lb. variation.

For operating the plant, the boiler is equipped with a recording pressure gage and integrating and recording steam-flow meter, a CO_2 recorder and a regulator for controlling the speed of the forced- and induced-draft fans. This reduces the fireman's chief duties to getting the coal into the stoker hopper with the weighing larry, watching the speed of the stoker to see that no live coal goes to the ashpit and that the water is maintained at the proper level in the boiler, and make such slight adjustments as are necessary to maintain the CO_2 at about 15 per cent. On account of the simple arrangement of the plant and its automatic control only two men are required on a shift, a watch engineer and

a fireman. When the other turbine and boiler are installed, they will be able to operate these easily also.

After a plant has been installed and put into operation, the really big job begins; namely, to get out of it what the station was designed to do. At the Duratex plant today, even the most optimistic hopes of the designers and manufacturers are being surpassed. These results are due to the efforts of A. C. Smith, Jr., in charge of mechanical operation and maintenance of the entire plant, E. A. Earl, chief operating engineer and his operating staff in co-operation with R. De V. Hope, works manager.

DATA ON PRINCIPAL EQUIPMENT IN DURATEX COMPANY'S PLANT

BUILDING DIMENSIONS, ETC.

Length of turbine room, inside	30 ft.
Width of turbine room, inside	42 ft.
Length of boiler room, inside	43 ft.
Width of boiler room, inside	42 ft.
Distance basement floor to turbine-room floor	7 ft.
Distance turbine operating floor to lower chord of roof truss	26 ft.
Ratio of boiler-heating surface to boiler-house floor area	3.7 to 1

BOILERS AND SUPERHEATERS

Manufacturer of boilers	Babcock & Wilcox
Number of boilers (ultimately 2)	1 installed
Baffles, type	Turner
Steam drums, 2	42 in. O.D. x 21 ft. 6 in. long
Tubes, number of, 160; arranged 10 high by 16 wide.	
Number of passes	3
Water heating surface per boiler	3,330 sq.ft.
Boiler working pressure	175 lb. gage
Superheaters	Babcock & Wilcox
Square feet of heating surface	234.4
Ratio of superheater surface to boiler heating surface	1 to 14.2

Superheater performance:

Boilers operated at normal rating, steam containing not over 1 deg. moisture, superheat 100 deg. F.

ECONOMIZERS

Manufacturer	Babcock & Wilcox
Number (ultimately 2)	1 installed
Type	Duratex
Number and size of tubes	182
Size	2 in. O. D. x 10 ft. 2 in.
Square feet of heat surface	994
Ratio of economizer surface to boiler heating surface	1:3.35

Economizer performance:

With exit gas temperature leaving boiler, at 100, 200 and 300 per cent rating, 500, 610 and 720 deg. F. respectively, with feed water entering economizer at 210 deg. F., gases leave at 385, 489 and 585 deg., and feed water enters boiler at 268, 276 and 295 deg. respectively.

FORCED-DRAFT FANS

Manufacturer	Rateau Battu Smoot Co.
Number (ultimately 2)	1 installed
Type	Twin helicoidal, turbine driven
Speed	4,000 r.p.m.

Capacity, 20,000 cu.ft. per min. compressed to 5½ in. of water.

INDUCED-DRAFT FANS

Manufacturer	Rateau, Battu, Smoot Co.
Number (ultimately 2)	1 installed
Type	Twin helicoidal turbine-driven.
Speed	5,000 r.p.m.

Capacity, 28,700 cu.ft. per min. compressed to 5½ in. of water.

STOKERS

Manufacturer	Combustion Engineering Corp.
Kind of stoker	Coxe, chain grate
Width of grate	8 ft. 8½ in.
Length of grate	10 ft. 4 in.
Number of stokers per boiler	1
Grate area	90 sq.ft.
Ratio of water-heating to grate surface	37:1
Stoker engines, Acme, 4 x 5 in.	1
Manufacturer	Automatic Furnace Co.
Coal	Anthracite buckwheat
Ultimate analysis of coal upon which stoker performance is based:	
Moisture	14.65 per cent
Volatile matter (dry basis)	8.74 per cent
Fixed carbon (dry basis)	76.56 per cent
Ash (dry basis)	14.70 per cent
Heat value (dry basis) B.t.u.	11,725
Efficiency performance of stoker (by test):	
Per cent of boiler rating	146
Per cent of CO_2 in escaping gases at boiler outlet	12.19
O_2	7.41
Per cent of CO	0.1
Average furnace draft over fire	0.129 in.

Capacity performance of stokers, guarantee, burning anthracite No. 3 buckwheat: 150 per cent boiler rating continuously; 200 per cent boiler rating for four hours Burning bituminous coal: 225 per cent boiler rating continuously, 300 per cent boiler rating for four hours.

Actual operation has shown the stokers to be good for at least 250 per cent normal rating of the boiler when burning a poor grade of anthracite No. 3 buckwheat.

BOILER SETTINGS

Height of bottom of front header from floor	13 ft. 0 in.
Height from stoker to nearest tubes (front end)	10 ft. 6 in.
No. 1 fire brick	Queens Run Fire Brick Co.
Volume of combustion chamber	840 cu.ft.
Volume of combustion chamber per sq.ft. of active grate area	9.35:1

Arches, M. H. Detrick Co., flat suspension, 1 per boiler, 4 ft. 3¼ in. long.

STACK

Type	Steel-plate
Inside diameter at top	5 ft.
Height above grate	50 ft.
Area of chimney inside at top	19.6 sq.ft.
Ratio of chimney area to grate area	1:4.6

Draft equipment capable of operating the boiler at 300 per cent rating, when burning anthracite buckwheat, having a heat value of 11,500 B.t.u.

TURBO-GENERATOR

Manufacturer	Ridgway Dynamo & Engine Co.
Number of units (ultimately 2)	1 installed
Type	Rateau
Rating	625 kva. at 0.80 P. F.
Number of stages	4
Radial clearance (min.)	¼ in.
Blading material	Parsons Bronze
Generator	Three-phase, 60-cycle, 440-volt
Manufacturer	Ridgway Dynamo & Engine Co.
Exciter, direct-connected	115 volts
Rating	10 kw.

Performance: Operating conditions, 150 lb. gage, 75 deg. superheat, 15 lb. back pressure vacuum, corrected to 30-in. barometer.

Kw. Output of Generator	Lb. of Steam per Kw.-Hr.
250	12,000
375	15,000
500	19,000
625	25,000

When operating at 20 lb. gage back pressure and 500-kw. load, 25,800 lb. of steam per hour.

FEED-WATER HEATERS

Number	1
Type	Open
Manufacturer	H. S. B. W. Cochrane Corp.
Size	1,000 hp.
Capacity, 40 to 200 deg. F. water per hour	30,000 lb.

BOILER-FEED PUMPS

Manufacturer	Worthington Pump & Mach. Corp.
Number	1
Type and size, pot valve, plunger duplex	12 x 7 x 12 in.
Capacity	125 gal. per min.
Discharge head	300 lb.

HEATING-SYSTEM, WET-VACUUM PUMPS

Manufacturer	Nash Engineering Co.
Number	1
Type	Jennings Turbine
Capacity, gal. condensate per min.	90
Manufacturer	Dean Steam Pump Co.
Type	Single piston
Number	1
Size	8 x 10 x 12 in.
Capacity, gal., condensate per min.	100

MISCELLANEOUS MECHANICAL EQUIPMENT

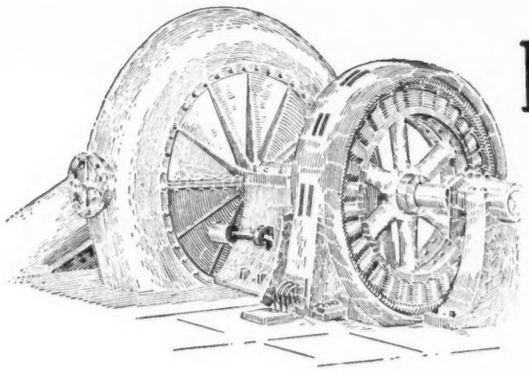
Coal and ash handling	Gifford-Wood Co.
Traveling coal-weighing larry	Manning, Maxwell & Moore, Inc.
Larry scales	Fairbanks Co.
Diamond soot blowers	Power Specialty Co.
Boiler draft regulator	Rateau Battu Smoot Co.
Turner boiler baffles	Engineer Co.
Ducts on side of boiler	H. W. Johns-Manville, Inc.
Automatic non-return valves	Schutte-Koerting Co.
Blowoff valves, (seatless type)	Yarnall Waring Co.
Blowoff plug cocks	A. W. Cadman Mfg. Co.
Throttle valve	Lunkenheimer Co.
Gate valves	Chapman Valve & Mfg. Co.
Reducing valve, 200 to 100 lb.	Rateau Battu Smoot Co.
Reducing valve, 100 lb. down	Foster Engineering Co.
Multi-port back-pressure valve	H. S. B. W. Cochrane Corp.
Safety valves	Consolidated Safety Valve Co.
CO_2 recorder	Jos. W. Hays Corp.
Steam-flow meter	General Electric Co.
Steam-pressure gages	Asheroft Valve Co.
Recording thermometer	Bristol Co.
Recording pressure gage	Foxboro Co.
Oiling system	Rateau Battu Smoot Co.
Traveling crane	Chisholm-Moore Co.

MISCELLANEOUS ELECTRICAL EQUIPMENT

Main switchboard, 9 panels	Westinghouse Elec. & Mfg. Co.
Rotary-converter switchboard, 5 panels	General Electric Co.
Rotary converters (2-165 Kw.)	General Electric Co.
Transformers (6-440 to 187 volts)	General Electric Co.
Rotary converters (1-2 Kw.)	Westinghouse Elec. & Mfg. Co.

PIPING, ETC.

Piping	Whitney-MacDonald Company, Philadelphia, Pa.: High-pressure, 4 in. and over, full-weight steel pipe, Vanstone joints with rolled steel flanges; below 4 in., full-weight steel pipe, rolled steel flanges, screwed and peined; outlets—welded outlets and steel fittings; piping—low-pressure steam and exhaust, 12 in. and over standard-weight steel pipe, Vanstone joints, cast-iron flanges; under 12 in.—standard-weight steel pipe cast-iron flanges, screwed and peined.
Pipe Covering	Johns-Manville Co., low-pressure, exhaust steam and feed water lines, standard thick 85 per cent magnesia High-pressure steam, double thick 85 per cent magnesia Feed-water heater—1 in. magnesia block, ½ in. cement Boiler drum heads—2 in. magnesia block, ½ in. cement Boiler drum top half—1½ in. magnesia block, ½ in. cement
Consulting Engineer	B. F. Wood, Wood Hulse Yates Co., New York City



ELECTRIC MOTORS FOR DRIVING PUMPS

By R. A. Jones*

Characteristics of Reciprocating, Rotary and Centrifugal Types of Pumps — Direct-Current and Alternating-Current Motors — Speed Control of Motors—Motor Controllers for Pump Applications

THE problem of selecting the proper capacity, type of motor and type of control for a specific pumping application so as to provide maximum simplicity and efficiency involves detail consideration of the starting and running characteristics of the pump and also the duty cycle imposed by the demand for water. Owing to the mechanical construction of the plunger pump, which involves tightly packed stuffing boxes and sliding pistons, the initial breakaway torque required for starting may equal 125 to 250 per cent of normal full-load torque, depending on the tightness of the stuffing boxes, fit of the pistons, etc. Immediately upon starting, the pump delivers full capacity per stroke, with the result that full-load torque will be required throughout the remainder of the starting period if the pump is connected to a constant-pressure system. Frequently, large reciprocating pumps are equipped with a bypass, which relieves the pressure during the starting period so as to decrease the starting torque required from the driving motor.

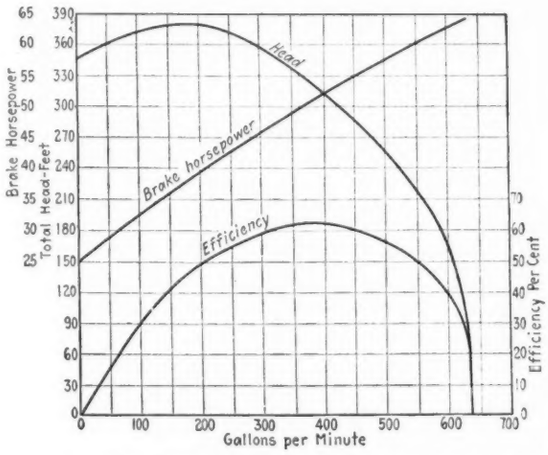


FIG. 1. CURVES SHOW HOW THE POWER REQUIRED TO DRIVE A CENTRIFUGAL PUMP INCREASES AS THE HEAD IS DECREASED

The running characteristics of this type of pump are comparatively simple. Since a positive amount of water is delivered by each stroke, the capacity is independent of the pressure and the requirements vary directly with the speed if the pressure is constant and directly with the pressure if the speed is constant.

The pumping action of rotary pumps resembles that of a multiple-cylinder reciprocating pump, in that a positive amount of water is discharged per revolution regardless of the pressure (slip neglected). The absence of piston-rod packing and sliding cylinders reduces the initial starting torque to 60 per cent or less of the full-load torque.

The centrifugal pump differs from the two foregoing types in both the running and starting characteristics. The average centrifugal pump requires from 20 to 30 per cent of full-load torque at starting and 50 to 60 per cent of full-load torque at approximately full speed, provided the discharge valve is closed. If the discharge valve is open during the starting period, the initial starting torque will be the same, but full-load torque will be required at full speed.

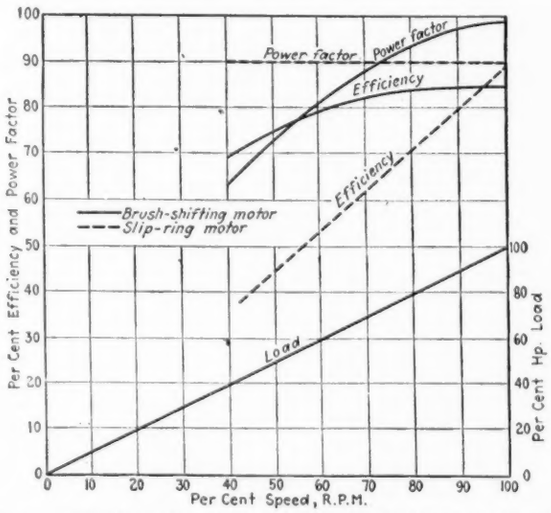


FIG. 2. EFFICIENCY AND POWER-FACTOR CURVES FOR SLIP-RING AND BRUSH-SHIFTING TYPES OF MOTORS AT DIFFERENT SPEEDS WHEN DRIVING PLUNGER PUMPS

Since the principle of operation of the centrifugal pump is based on centrifugal force, and since a certain

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amount of water is rotated by the pump impeller blades during each revolution, the derivation of the following general rules for centrifugal pumps is evident:

1. The head developed varies as the square of the speed.

2. The quantity of the discharge varies directly with the speed.

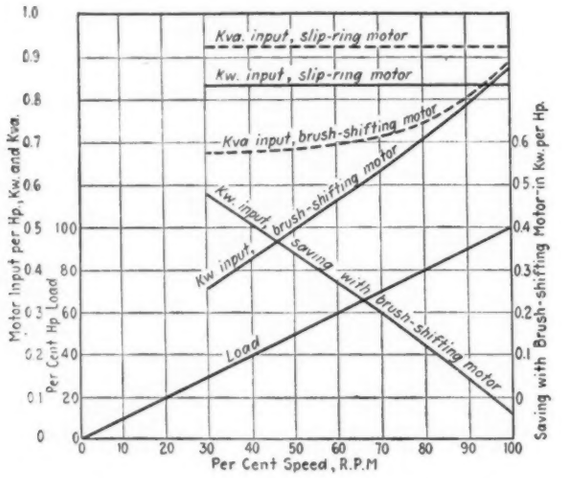
Kva. input, slip-ring motor
Kw. input, slip-ring motor
Kva input, brush-shifting motor
Kw. input, brush-shifting motor
Kw. input, saving with brush-shifting motor
Load
Motor Input per Hp., Kw. and Kva.
Per Cent Hp Load
Saving with Brush-shifting Motor in Kw. per Hp.
Per Cent Speed, R.P.M.

FIG. 3. POWER CONSUMPTION CURVES OF SLIP-RING AND BRUSH-SHIFTING TYPES OF MOTORS AT DIFFERENT SPEEDS WHEN DRIVING PLUNGER PUMPS

3. The horsepower required varies as the cube of the speed.

As illustrated by Fig. 1, the driving characteristics of centrifugal pumps are further complicated by the variation in horsepower and discharge caused by variation in head. These curves indicate that correct information is required in regard to the total discharge head of a centrifugal pump in order to determine the proper capacity of the motor. To provide for variation in head, continuous rated motors are generally selected having a capacity equal to approximately 120 per cent of the actual horsepower requirements.

To provide the starting and running characteristics for the different types of pumps as previously outlined, the following types of motors are generally used:

1. With direct-current supply, compound motors with approximately 20 per cent series windings are used for both the plunger and rotary pumps so as to provide the necessary starting torque without drawing an excessive current. If adjustable-speed operation is necessary, the motors should be compound-wound regardless of whether the speed adjustment is to be by field or armature control. The question of field versus armature control for adjustable-speed operation with direct-current motors is largely dependent upon the amount of speed reduction desired or the extent of operation at the reduced speeds. In general, however, the increased efficiency with shunt-field control will more than offset the slight increase in cost of this type of equipment.

2. Direct-current motors for centrifugal pumps should be of the compound-wound type having approximately 10 per cent series winding. This amount of compounding is sufficient to cause a slight decrease in speed in case of overload, which characteristic tends to relieve the overload condition rather than aggravate it, as would be the case with a shunt-wound motor.

For adjustable-speed operation the same considerations are involved as those mentioned in the foregoing for the plunger and rotary pumps.

With alternating-current supply, the following types and capacities are recommended for the different pumps:

1. For plunger pumps, squirrel-cage motors are permissible, up to and including 5 hp., provided the power company will permit motors of this capacity to be thrown directly across the line. For larger capacities, wound-rotor motors of either the slip-ring or automatic self-starting types should be used, as they will develop adequate starting torque without drawing excessive line current.

For varying-speed service with plunger pumps the slip-ring type motor with its large secondary rheostat losses, has been replaced in many cases by the adjustable varying-speed brush-shifting type of alternating-current motor. This motor has starting characteristics similar to that of the slip-ring type, but has a better efficiency at reduced speeds, as indicated by the curves, Fig. 2. The kilowatt-hour saving due to the use of this type of motor instead of the slip-ring type is illustrated by the curves of Fig. 3.

2. For rotary pumps squirrel-cage motors are frequently used up to 50 hp., but it is preferable to use slip-ring motors for units above this capacity. For adjustable-speed service the operation of the brush-shifting and slip-ring types of motors would be the same as that described for the reciprocating pumps.

3. For centrifugal pumps it is desirable to use the slip-ring type of motor for the larger capacities; however, it is permissible to use squirrel-cage motors up to approximately 500 hp. Above 500 hp. the slight increase in cost of the slip-ring equipment is more than offset by the advantages of smooth acceleration and minimum starting current.

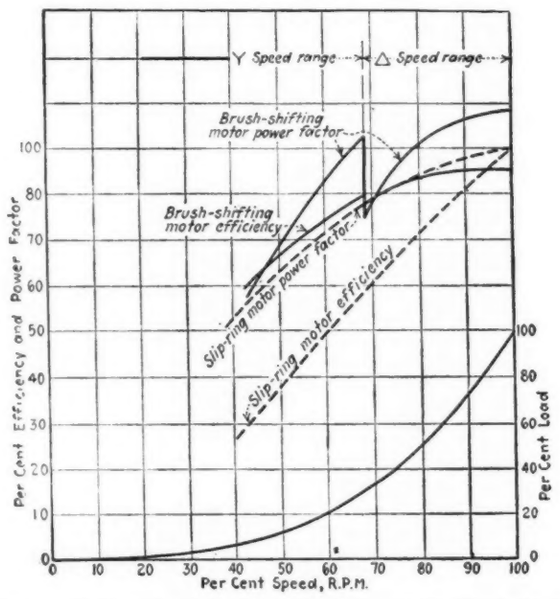

FIG. 4. EFFICIENCY AND POWER-FACTOR CURVES OF SLIP-RING AND BRUSH-SHIFTING TYPE MOTORS AT DIFFERENT SPEEDS WHEN DRIVING CENTRIFUGAL PUMPS

From 100 per cent speed down to about 68 per cent speed the windings of the brush-shifting type motor are connected delta; for lower speeds the windings are connected star.

For installations requiring constant-speed motors of 75-hp. capacity and larger, the synchronous type of ma-

chine is often used because of the power-factor correction possible, even though the line disturbance during the starting period may be the same as that with a squirrel-cage motor. For slow-speed, direct-connected applications, the synchronous motor is especially applicable, from the viewpoints of power factor and first cost. For adjustable-speed operation the brush-shifting type of motor is recommended in place of the slip-ring

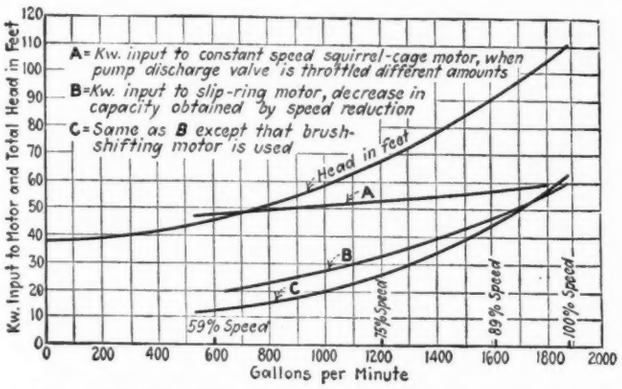

FIG. 5. KILOWATTS INPUT REQUIRED BY DIFFERENT TYPES OF MOTORS DRIVING CENTRIFUGAL PUMPS AT DIFFERENT SPEEDS

type if an appreciable amount of speed reduction is required. The comparative efficiency and power factor of these two types and the total saving in kilowatt-hours by the use of the brush-shifting motor are illustrated by curves, Figs. 4 and 5, respectively. Fig. 5 also shows the undesirability of reducing the discharge of a centrifugal pump by throttling.

In addition to the considerations already mentioned for the different types of pumps, the duty cycle of the pumping operation should be considered. For example, sewage-disposal plants, where it is desirable to maintain the sewage level in the collecting pool at certain levels, and with filtration plants where the water level in the storage tank should be maintained constant, and also with hydraulic systems, the expected cycle of water demand should be thoroughly analyzed and, if possible, the pump units so proportioned that some will run continuously at constant speed and the variable capacity be supplied by the starting and stopping or speed variation of a few units. Where frequent starting and stopping may be required, as often happens with hydraulic systems having insufficient accumulative capacity, it is advisable to use wound-rotor motors if the power supply is alternating-current, since frequent starting service will overheat the rotor of a squirrel-cage induction motor.

The problem of motor application naturally involves the types of control. In many cases the control is the predominant feature. Data for specific recommendations for the control of any motor-driven pump properly include the characteristics of the pump and motor, and the conditions under which the pumping is to be done.

Standardized control equipments for pumping applications may be classified as hand, magnetic or hydraulically operated. Each of these divisions may be subdivided into (1) starting, and (2) starting and speed regulating.

Hand-operated starting or speed-regulating equipment is ordinarily used only with small or medium-sized motors and under the following conditions: (1) When an operator who has other duties is available; (2) when there is not necessity for frequent starting, stopping or changing of speed; (3) when no damage will be done to any equipment or loss of efficiency occur in case the amount of liquid pumped should become more or less than that actually required.

Magnetic equipments are available for remote control by means of push-button stations, float switches, pressure switches or thermostats. The use of these devices assures correct starting of the motor, eliminates the necessity of trained operators, permits the control station to be located conveniently to the operator and the control panel to be distant, where more space is available.

Hydraulically operated equipments are particularly applicable to pumps whose speed must be continually changed to conform to fluctuating demands for the liquid being pumped.

The importance of properly applying motors and control to pumps cannot be appreciated without realizing our present-day dependence on the one type of apparatus. There is scarcely a manufactured product that does not depend at least partly upon pumping. In coal mining the problem of handling the water is equal to that of removing the coal. Of equal importance is the water supply and fire protection for cities and the irrigation and drainage of large tracts of productive land which depend wholly upon pumping equipment. These illustrations show that pumps play an important part in modern affairs and that methods of increasing the effectiveness and economy of their driving power are worthy of consideration.

Voltage Ratio of Rotary Converters

In a single-phase rotary converter the maximum alternating voltage is equal to the direct voltage. This makes the effective alternating voltage, or what the voltmeter will read, equal to the direct voltage times 0.707. This voltage ratio is the same for any single-phase converter and cannot be changed by regulation of the field strength alone, as in a direct-current generator. A change in field strength changes the phase relation between the alternating voltage and current as in any synchronous motor. This refers to a machine converting alternating current into direct. If the machine was changing direct current into alternating and the field strength were changed, its speed would change as with any direct-current motor, which would result in a change of alternating-current frequency, but the voltage would remain practically constant. The voltage ratio of any converter is fixed and is given in the table.

Phase	Direct Voltage Equals Alternating Voltage Divided By	Alternating Voltage Equals Direct Voltage Times
1	0.707	0.707
2	0.707	0.707
3	0.612	0.612
4	0.500	0.500
6	0.354	0.354
6 double delta	0.612	0.612
6 diametrical	0.707	0.707

This means that in order to convert between standard voltages, special transformers must be used on the alternating-current side, to step down the supply voltage to its proper value. For instance, if it is desired to convert 220-volt three-phase alternating current to 220-volt direct current, the voltage needed on the alternating-current side of the rotary converter would be 220×0.612, or 135 volts, so three transformers would be needed to step down 220 volts to 135 volts.

Improving Hot-Water Distribution in Forced Circulating Systems

By H. M. PHILLIPS
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EXCEPT for very small installations forced circulation is to be preferred to natural circulation as being the more economical, cheaper to install and less likely to fail through accidental or unforeseen departures from the theoretical conditions upon which its installation was based. In fact, under some conditions it is the only possible solution of the problem.

When all the connections can be placed on a single line, as illustrated in Fig. 1, the design of the system is a very simple matter. Cold water is supplied to the heater under the same pressure as the cold-water supply of the plant, the pump being used only to cause circulation through the system. The size of the hot-water main will be determined from the amount to be supplied in the same manner as for a cold-water supply. The only other points to be decided are the size of the return main and of the circulating pump, which will depend upon the allowable difference between the temperature of the water in the heater, which may be assumed to be the same as that of the nearest hot-water connection on the main, and the required temperature at the connection farthest from the heater. The method of calculation is readily illustrated by a practical example:

SOMETIMES the system employed for distributing hot water through a plant is only partially successful. This is especially likely to be the case when an old system has been enlarged or otherwise altered. In some cases the remedy is comparatively simple, in others quite extensive alterations may be necessary. The difficulty is never insurmountable, but a solution is frequently attempted without a clear knowledge of the principles involved and a careful study of the individual case with unsatisfactory results.

The hot-water main, not including the return, is to be 1,000 ft. long; the temperature to be maintained at the last outlet is 160 deg. F., and the temperature maintained in the heater is 190 deg. F. The number of heat units lost in the hot-water main should first be determined. This main will naturally be insulated, and although the loss of heat will vary to a considerable extent with the nature of the insulation and the location of the pipes, an assumption of a loss of 0.45 of a B.t.u. per hour per square foot of pipe surface for each degree of temperature difference between the water and the surrounding air will be high enough for good commercial coverings. The area of 1,000 ft. of 2-in. pipe is 622 sq.ft.; the temperature may be taken as the mean between the two ends, or 175 deg. Assuming the temperature of the surrounding air to be 60 deg., the loss of heat will be $622 \times 0.45 \times (175 - 60) = 32{,}180$ B.t.u. As a loss of temperature of 30 deg. has been allowed between the two ends of the pipe, the amount of water required to supply the lost heat will be $32{,}180 \div 30 = 1{,}073$ lb. per hour, or 2.1 gallons per minute.

A more uniform temperature along the main might be desirable; with three times the flow of water the tank temperature may be reduced to 170 deg., or the temperature of the last outlet raised to 180 deg. Even with this flow the pump may be very small, the head required for forcing the water through the pipe being lower than that for which a pump is usually designed. When such a system is operated in connection with a boiler room where the temperature of the boiler-feed water is not above 180 deg., it may prove an economy to omit the circulating pump and allow the return pipe to discharge into the feed-water heater at a rate sufficient to maintain the desired temperature at the hot-water outlets. This will necessitate supplying a larger amount of heat to the water heater, but as the surplus is returned to the boiler through the feed water, there is very little ultimate loss; it may, however, be necessary to provide a larger water main than would be used with the circulating pump. On account of the small flow of circulating water the return pipe may be of small diameter, although it is advisable to use 1-in. as the minimum on account of the mechanical weakness and shorter life of the smaller sizes. It would also be unnecessary to carry the 2-in. pipe the full length of the main; the part near the farther end could probably be reduced to 1-in. with intermediate sizes between it and the 2-in. near the first outlets; which would reduce the first cost and also the heat losses. As a rule it would be well to install a pump of double the required capacity in order to allow for additions to the system which may demand a disproportionate increase in the amount of circulating water.

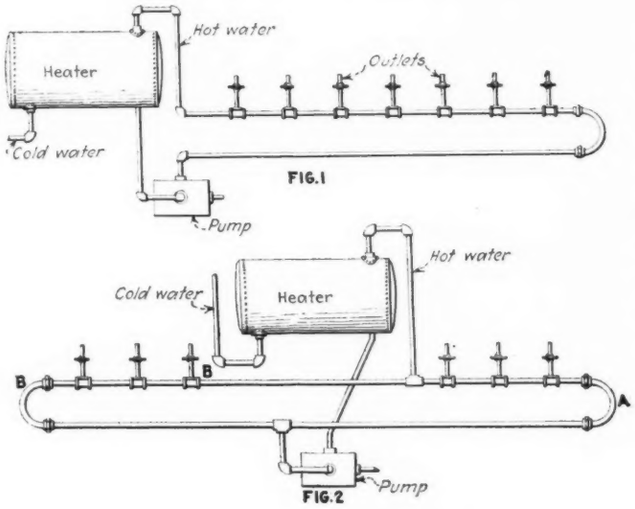
A Two Branch System

It is not always practicable to confine the circulating system to a single main and return, although it is certainly desirable to limit the number of branches as much as possible without undue expense. Whether or not a two-branch system, as illustrated in Fig. 2, should be installed will depend upon the size of pipe to be used and the length of the run. If we assumed that it is necessary to locate the heater at the central point, but a branchless system might be installed as shown in Fig. 3. In this case the pipe from the heater to point *A* would have to be larger than in Fig. 2 and the return from branch *A* to the point where it connects to branch *B* would have to be the same size as branch *B*, a considerable increase in the cost of pipe and a slight increase in the heat loss of the system due to the larger pipes. If the pipes are long and of considerable size, economy will demand connections as shown in Fig. 2, but the actual head required to maintain circulation is so small that a very slight resistance to the flow in one branch may be sufficient to cause practically

the entire amount of circulating water to flow through the other. It follows that unusual care should be taken to eliminate the formation of air pockets or other obstructions in the return lines.

Improving a Poor Design

Fig. 4 represents a condition that may occasionally be found, undoubtedly giving unsatisfactory service. It will readliy be seen that there is a strong tendency for practically all of the circulating water to pass through branch 1, it being short and close to the pump, while the



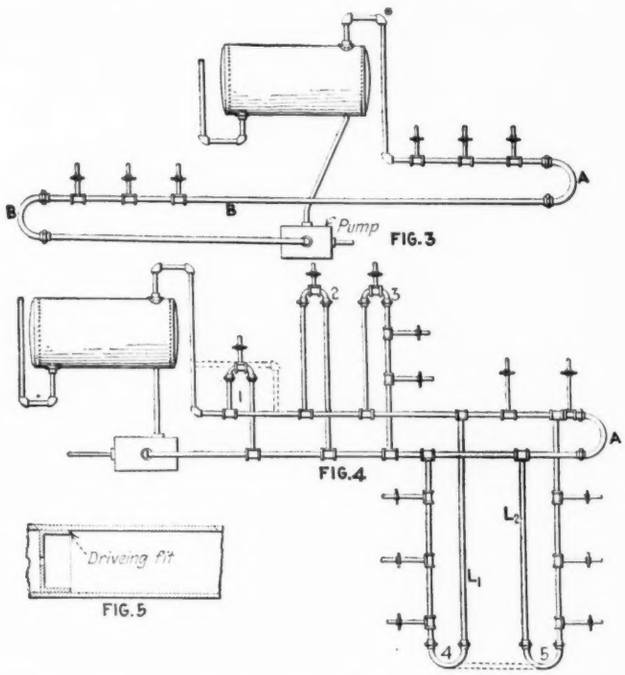
FIGS. 1 AND 2. SIMPLE HOT-WATER CIRCULATING SYSTEMS

Best arrangement is Fig. 1. In larger systems two branches, are necessary, as in Fig. 2.

amount that carries through branch 5 will be negligible on account of its distance from the pump and the ready passage offered by the connection between the end of the main and the return line. In some cases satisfactory results may be obtained by quite simple modifications. As the final outlet on the main is but a short distance beyond branch 5, it may be feasible to break the connection between the main and return at point *A*. This will cut off circulation at the last outlet, but will give branch 5 a little better chance while only a small quantity of water need be drawn to bring hot water to the last outlet on the main. Branch 1 might be treated in the same manner by breaking its return connection, or if this is not permissible, the main might be brought to the outlet as indicated by dotted lines. Branches 4 and 5 might be changed to a single branch by cross-connecting as shown by dotted lines, cutting out the return lines and connecting one of the supply lines to the main return line instead of the hot-water main; in this case it may be necessary to increase the size of the hot-water pipe in one of the branches. A similar connection could be more readily made on branches 2 and 3, and with a liberal excess of circulating water over the amount theoretically required, it is probable that satisfactory service would be obtained even though one of the two remaining branches took much more than its share of the circulation.

It is not always feasible to reduce the number of branches to the extent indicated, and, although effort should be made to reduce the number to a minimum, proper restriction of the amount of flow in each branch will give satisfactory service in nearly all cases. It will usually be found that the return main is large enough to carry several times the small amount of water theoretically necessary to maintain the desired temperature with very small loss of head due to friction. If the flow in each branch is restricted to somewhere near the theoretical amount, there will be pretty nearly the same head acting on each branch to maintain its circulation, which head will generally depend on the speed at which the circulating pump is operated. Restriction of flow may in some instances be satisfactorily accomplished by means of a globe valve, locked in position after being adjusted by trial to give satisfactory results.

As an illustration we may suppose that the system illustrated by Fig. 4 is equipped with a globe valve at point *A* and in the return of each branch. Starting with the branch that is supposed to take the greater part of the circulating water (No. 1 in the present case) the valve in the return should be gradually closed until the majority of the other branches become hot or until only enough water flows through the branch in question to keep it at the proper temperature. This procedure should furnish hot water to branches 2 and 3 and perhaps to 4 and *A*, but would probably fail to supply hot water in 5. Throttling branch 2 would then increase the supply to the remaining branches, but 5 would be pretty sure to be robbed by *A*, which would



FIGS. 3 TO 5. LAYOUTS OF LARGE HOT-WATER SYSTEMS

Fig. 3 is too expensive for large systems, while Fig. 4 requires careful adjustment. Fig. 5 shows a regulating orifice for small pipes.

be throttled in turn. The best results are generally obtained by repeated adjustments which leave each valve open as wide as is possible and still obtain proper circulation in all branches.

Orifices for Adjusting Flow

Where only a very small flow is permissible, as in a system having a large number of branches, throttling by means of a globe valve is likely to give unsatisfactory results. If the valve is incorrectly installed so that it closes with instead of against the pressure, the play of the disk upon the stem is almost certain to

produce variable results, and in any event changes of temperature or very small amounts of sediment collecting under the disk are likely to cause undue fluctuations in the amount of flow. In such cases the use of an orifice may give fair satisfaction.

Satisfactory Orifice for Small Pipes

A satisfactory orifice for small pipes may be made as shown by Fig. 5, which should be inserted at a union so as to be accessible for cleaning; for large pipes the best method is to use a blind gasket, of metal, with a hole drilled in the center. If the diameter of the orifice is not more than one-tenth that of the pipe, the quantity of water passed will be measured quite closely by the formula $Q = a \times c \times \sqrt{2gh}$, in which Q = cu.ft. per sec., a = area of orifice in sq.ft., g = acceleration due to gravity = 32.16 ft. per sec., and h = the pressure on the orifice measured in the feet of head, which for water equals the pounds per square inch $\times$ 2.307; c is a constant, about 0.63 in the present case, signifying that the actual area of the narrowest part of the water jet is 0.63 the area of the orifice. Reducing to terms more familiar to the average engineer, we have gal. per min. = $18.8 \times d \times p$, where d is the diameter of the orifice in inches and p is the pressure on the orifice in pounds per square inch. Assuming an orifice $\frac{1}{16}$ in. in diameter, a difference in pressure of one pound between the hot-water line and return would cause a flow of 0.74 gal. per min., which would be sufficient to maintain the temperature in a branch of moderate length.

Allowing for a fall in pressure, 4 lb. on the orifice nearest the pump would pass only twice this amount, while 9 lb. would be necessary to triple it; therefore it is evident that a considerable number of such orifices could be installed without taxing the capacity of a 1-in. return line or requiring a pump of any considerable capacity. A more equitable distribution among the branches could be obtained by varying the sizes of orifices on different branches. Drawing a considerable amount of water would be likely to create such a fall in pressure in the supply main that the flow through some of the orifices would cease or be temporarily reversed, but in most cases the interruption would not be of sufficient duration to allow a serious fall of temperature in such branches. The foregoing formula is most accurate when applied to orifices with sharp edges drilled in thin plates; such an orifice is also slightly less liable to become choked and is easier to clean than one of the same diameter in heavy plate, which makes the construction shown in Fig. 5 preferable to a heavy plug with single small hole.

Semi-Diesel Cylinder-Head Packing

Even though it is a seeming paradox, it is true that the best cylinder packing for an oil engine is no packing at all. It seems to be the idea of the average engineer that he must use a thick packing in order to seal the joint securely. Even though it may be demonstrated that, theoretically, the more compressible the packing is the greater the elongation of the studs before "blowing" will occur, in actual practice a thick packing should be avoided. In designs where the head and cylinder flanges are faced straight across, the best possible packing is a thin sheet of copper. This sheet should be annealed and made perfectly smooth and straight. The flange surfaces should be cleaned and, if necessary, smoothed up with emery cloth. The copper gasket, which should rest inside the studs to keep it in place, will maintain a tight seal.

A slight blowing on starting is not harmful on a copper gasket and may serve to relieve any excessive cylinder pressure in a semi-Diesel engine. Some engines have this joint grooved for a round copper ring. In replacements the copper wire should be cut and the ends scarfed and soldered. The wire should also be annealed before using, so that it will compress easily. The copper wire gasket, undoubtedly, makes the best seal that can be secured. Some of the better-grade engines use a ground joint between the head and the cylinder. If the head was never removed, this kind of seal would be most superior. Unfortunately, it often becomes necessary to inspect the cylinder or remove the piston. It is almost impossible to tighten up enough to reseal this ground joint. Small particles, almost invisible to the eye, will prevent a perfect contact. In replacing this type of head, it is a good procedure to insert a copper sheet gasket. The use of vulcanized rubber or asbestos gaskets, even with wire insertion, is poor practice. The gasket seldom holds against the pressure, and the blowing of the joint at starting will cause the gasket to tear and be rendered worthless.

A word might be added about the "blowing" of this joint in a semi-Diesel engine. While it serves to relieve excessive cylinder pressure, the engineer should recognize it as an indication that he has pumped too much fuel into the combustion chamber on starting. He should give the pump fewer initial strokes on the next starting. If the engine "blows," the operator should retard the fuel pump stroke so that the oil injected is less. On starting an engine, the usual governor, since it is not in a state of perfect equilibrium, will give the fuel pump its greatest possible stroke, even more than full-load stroke, and the fuel injected exceeds the capacity of the engine. The pump handle should always be used to hold the pump stroke to a low value, until the engine has come up to speed.

In welding cast iron by the Thermit process, the material should be preheated only to a dull red. This compensates for the lower melting point of cast iron as compared with steel and results in a quiet pour and perfect fusion, according to the Metal & Thermit Corp., New York City. Experience covering a variety of cases is the basis for this recommendation. It might be supposed that such a low temperature as that corresponding to a dull red would not expand the cast iron sufficiently to prevent hairline cracks appearing in the Thermit steel, perpendicular to the line of break. Such, however, is not the case in actual practice; it has been found that the cast-iron sections are quite fully expanded at a dull red heat, and that perfect welds are obtained, with good fusion to the extreme edge of the collar.

Neglecting the anthracites and everything below the bituminous variety, we find that our real reserve of real coal in the United States amounts to about one trillion, eight hundred and sixty-three billion tons, including the known deposits whether workable or unworkable. But of this vast store only 16 per cent, or thereabouts, is workable by present methods, and of this 16 per cent we have already accounted for 3 per cent. And we have taken the best of it, mining, whenever possible, only the most workable seams of the best fuel.

Indicating the Ammonia Compressor

A family of charts are given for both isothermal and adiabatic compression. Indicator diagrams may now be studied without mathematical computation.

IF AN INDICATOR is attached to an ammonia compressor, a diagram similar to Fig. 1 is secured. This specific diagram was taken from a slow-speed machine, the high-speed compressor giving a diagram somewhat different in shape, as will be outlined later. In the diagram shown, horizontal distances represent cylinder volumes, while vertical distances represent pressures within the cylinder, and the area of the diagram represents to some scale the work done in compressing the ammonia. At *C* the piston is at the end of

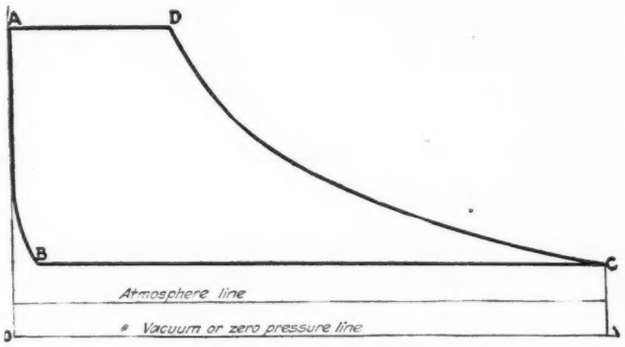


FIG. 1. INDICATOR DIAGRAM FROM SLOW-SPEED AMMONIA COMPRESSOR

its stroke and the cylinder is filled with ammonia vapor at a pressure represented to some scale by the distance *C* is above the base line, which is the zero absolute pressure line (— 14.7 gage). As the piston reverses and moves to the left, the vapor trapped in the cylinder is compressed, the pressure and volume ratio following the curve *CD*. At *D* the cylinder pressure equals the discharge-line pressure, and consequently during the rest of the piston stroke the vapor is forced out through the discharge valve at a constant pressure indicated by the horizontal line *DA*. The piston reverses, and as it retreats, any vapor left in the clearance space re-expands along the line *AB*. At *B* the suction valve opens, admitting vapor at a constant pressure until the end of the stroke at *C*.

The line marked *atmospheric line* is obtained by turning the indicator cock so that it is open to the atmosphere and then touching the pencil point to the revolving drum. The line represents the pressure exerted by the atmosphere. The vacuum line, or zero absolute pressure, is constructed by measuring from the atmosphere line a distance proportional to 14.7 lb.; as for example, if a 60-lb. spring is being used, the distance below the atmosphere line would be $\frac{14.7}{60}$, or $\frac{1}{4}$ inch.

The zero clearance line *AO* is drawn by first finding the clearance volume of the compressor. The ratio of the volume to the piston-displacement volume will determine the position; for example, if the clearance volume of a 10x20-in. compressor is found to be 15.7 cu.in., since the piston displacement volume is $0.7854 \times 10^2 \times 20 = 1{,}570$ cu.in., the ratio would be $\frac{15.7}{1{,}570}$, and if the diagram is 3 in. in length the clearance line would be $\frac{15.7}{1{,}570}$ of 3, or 0.03 in. to the left of the diagram. In slow-speed compressors the clearance is almost zero, being less than 1 per cent, so that the clearance line *AO* practically touches the end of the diagram as shown in Fig. 1.

In the compression of any gas such as ammonia vapor, the temperature will rise as the pressure increases. Since the object of compression in the refrigerating plant is to raise the pressure of the ammonia vapor to some value above the evaporating pressure corresponding to the available condenser temperature, the most economical compression would be one in which the heat of compression is removed by the jacket cooling as fast as it is generated. This would lower the power required by the compressor and also reduce the cooling demands on the condenser. If the compression could be carried out at a constant temperature corresponding to the temperature of the suction vapor, the process would be an isothermal one, that is, a constant temperature process. And the heat resulting from the work done on the vapor would be absorbed by the jacket water. The energy in the vapor at *D* would be the same as at *C*. Isothermal compression is impossible to realize, since at the beginning of compression the ammonia vapor is at a temperature much below that of the cylinder walls and jacket cooling water. The time interval of compression is very small, and the heat absorption by the compressor walls even during the final portion of the compression is by no means great, although the

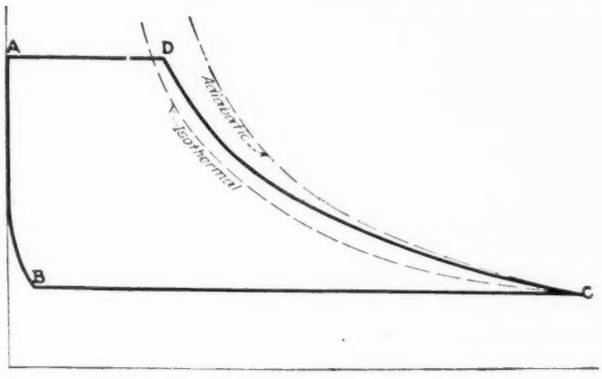


FIG. 2. DIAGRAM SHOWING ISOTHERMAL AND ADIABATIC COMPRESSION LINES

compression line *CD* has a slight increasing slope toward the isothermal curve, showing that some heat is lost to the walls.

If no heat were lost or absorbed by the vapor, the entire work of compression would reappear as heat in the vapor. As a consequence the compression line would be an adiabatic, requiring more power to do the work of compression than does an isothermal process. During the early part of the stroke heat is absorbed by the vapor and the compression curve may actually be above the adiabatic. As a rule, the actual compression curve should follow the adiabatic.

After securing an indicator diagram, the engineer ordinarily is unable to determine if his compressor is operating satisfactorily. The compression curve *CD* may appear smooth and of the proper curvature, but without an isothermal and adiabatic curve constructed through *C* the beginning of compression, no intelligent comparison is possible. As example, Fig. 1 to all outward appearance is an excellent diagram. The re-expansion of the clearance vapor from *A* to *B* is quite good and the compression line *CD* appears to be above reproach. In Fig. 2 the diagram is reproduced along

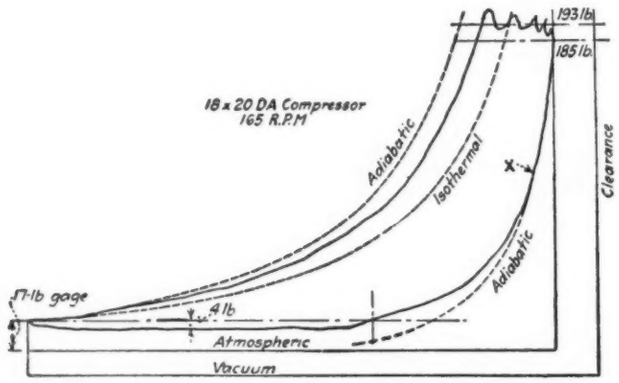


FIG. 3. DIAGRAM FROM A HIGH-SPEED COMPRESSOR

with the isothermal and adiabatic curves. It is at once clear that *CD* does not follow the adiabatic and approaches the isothermal. In this particular diagram leakage back through the suction valve was found to be responsible.

A diagram from a high-speed compressor appears in Fig. 3. It will be noticed that in this particular diagram the compression curve is midway between the isothermal and adiabatic lines. Since the compressor from which this diagram was secured had no cooling jacket save at the ends and heads of the cylinder, cooling was not the reason for the curve falling away from the adiabatic. It was found that there was a leak past the piston which would not have been discovered without the indicator. The part of the suction stroke showing

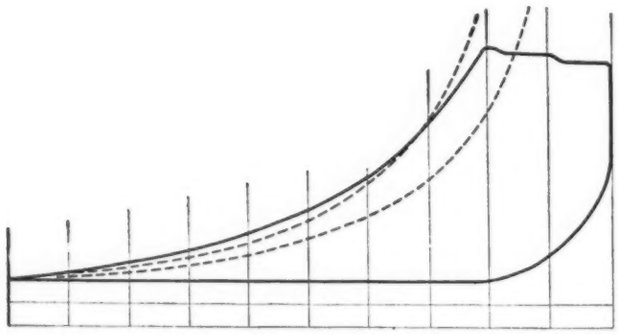


FIG. 4. COMPRESSOR WITH LEAKY VALVE CAGE

the re-expansion of the clearance vapor is interesting. For a small portion of the suction stroke the re-expansion is adiabatic. Since there must be some cooling by the cylinder-head jacket, it is evident that the piston either leaked or there was a slight leak back through the discharge valve. From the point *X* the re-expansion is isothermal, showing an absorption by the vapor of heat from the compressor walls. This reduced the net displacement of the cylinder, since less suction vapor enters when the suction valve opens.

The diagram from Fig. 4 is from a slow-speed compressor. The compressor line is above the adiabatic curve until about halfway in the piston stroke. The discharge valves were examined, and a minute leak was discovered between the valve cage and cylinder head. This leak allowed the discharge vapor to flow back into

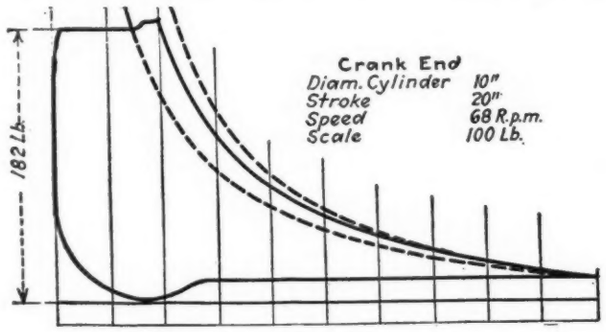


FIG. 5. CORRODED SUCTION VALVE

the cylinder when the cylinder pressure was low. The large re-expansion of the clearance vapor was also traceable to this leak.

Fig. 5 reveals an excellent compression line, but the suction line has a decided curve. This was found to be caused by a corroded suction-valve stem. This did not affect the volumetric efficiency of the machine, but did throw a slightly greater load on the compressor due to the lowered suction pressure.

The compressor from which Fig. 6 was secured had been falling down in capacity, the reason for which was not outwardly apparent. The indicator diagram showed that the compressor did not start until the piston had advanced about 20 per cent in its stroke. The suction valve was found to stick, refusing to close promptly,

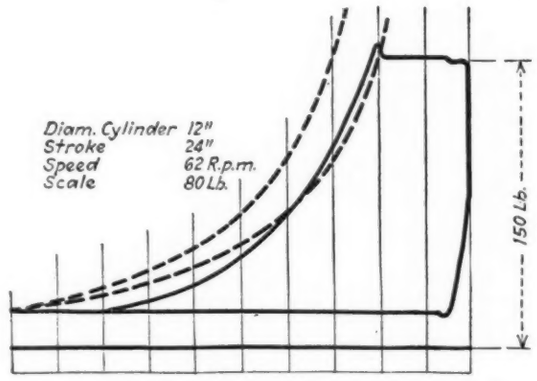


FIG. 6. DIAGRAM SHOWING STICKING VALVE

thereby allowing the vapor to flow back into the suction line.

None of these defects could have been discovered without the use of the indicator. Instead of following the customary process of elimination in locating compressor defects, an engineer should secure and use an indicator at stated periods, say once a week.

It is possible to construct the isothermal and adiabatic lines on any diagram. The equation of the isothermal curve is $P_1 V_1 = P_2 V_2$; that is, the pressure times the volume at any given point is equal to the pressure times the volume at any other point on the

curve. It is not difficult to construct this curve, although somewhat tedious. On the other hand, the construction of the adiabatic curve is difficult since the pressure and volume values involve the use of an exponent, the adiabatic equation being $P_1 V_1^n = P_2 V_2^n$ and n for ammonia is taken as 1.3. To avoid long computations, various tables have been constructed giving

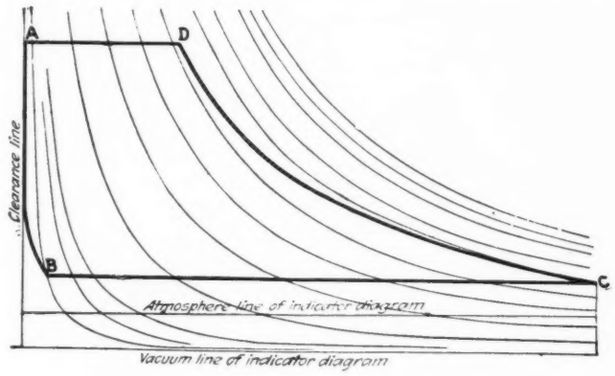


FIG. 7. METHOD OF USING ISOTHERMAL AND ADIABATIC CHARTS

values of P and V for several initial or suction pressures. Even with these tables the task of making the curve will consume some time.

If a set or family of isothermal or $PV = C$ curves were constructed, then by settling the initial compression point at the proper place, the correct isothermal curve could be traced on the indicator diagram. Likewise with a set of adiabatic curves the correct adiabatic curve could be erected on the diagram and a comparison of compressor performances made. In the special insert a set of adiabatic and a set of isothermal curves are shown. The method of using the chart is shown in Fig. 7. The indicator diagram is first tacked or otherwise held on a drafting board. The vacuum or zero absolute pressure line is laid out, as is also the clearance line; since the clearance in all compressors is small, no great error is made if the clearance line is drawn to coincide with the vertical portion of the re-expansion line AB. The isothermal family of curves is then placed over the indicator diagram so that the clearance and vacuum lines coincide with those of the diagram. The isothermal line which passes through C is then the isothermal which would be made by the indicator pencil if the compression were isothermal. By pin pricking through the chart, the curve may be readily transferred to the indicator diagram. Likewise, by placing the set of adiabatic curves over the indicator diagram, the correct adiabatic may be laid out. If no curve passes directly through the point C, by interpolating between the two adjacent curves the proper curve may be obtained. It makes no difference what pressure or volume scale is used, the curve passing through C is always the correct one.

With these two charts the engineer can intelligently check his compressor's operation with the minimum of effort and the construction of the adiabatic and isothermal curves will involve no errors which are likely to occur with a mathematical computation. The charts are based on ratios of pressures and volumes, and the adiabatic and isothermal curves through the compression starting point are always the correct curves. This is the first time such adiabatic curves have been published.

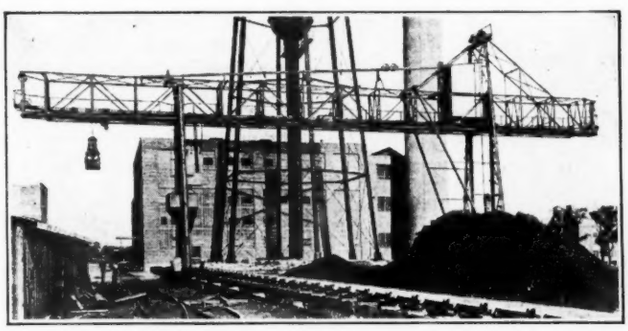
Gantry Cranes Now Used for the Smaller Plants

Until recent years gantry cranes have been used only in large sizes for unloading boats or handling large quantities of coal, in comparatively large plants. But it is becoming increasingly evident that the storage of coal is a necessity, in the small and medium-sized plant as well as in the large, so that the mines may operate not only at the most favorable seasons, but throughout the year at as nearly a constant rate as possible.

For such storage the gantry crane has many advantages. It covers the entire yard, so that all material stored can be reclaimed with the grab bucket. The moving parts are comparatively few and light, permitting operation at high speed. Repairs are minimized and the life of the crane can be figured at not less than 20 years, assuming that the structure is painted occasionally to prevent rusting. With a gantry crane serving the storage, the danger of loss from fire is practically eliminated, as any fire starting in the coal pile can be dug out in a short time and at very small cost.

To simplify construction, lessen weight and thus reduce the investment so that this type of crane will be available for the small plant, the Watson Company, of Milwaukee, Wis., has brought out a line of gantry cranes of the so-called rope type, lighter than the man-trolley type and one which may be operated faster. Coal is unloaded direct from railroad cars into a hopper supported by the vertical risers of the crane, from which it may be put into storage, to be reclaimed later as needed, or else transferred directly to the plant on a belt conveyor.

At the plant shown, the total initial investment in the yard, including rails, foundations and crane, was



"ROPE" TYPE GANTRY CRANE SERVING A PLANT OF MODERATE SIZE

$25,000. The annual cost of operation, when handling 30,000 tons of coal, is approximately as follows:

Interest, depreciation and insurance, etc.	$3,750
Labor charged to crane for handling of coal only	570
Power	450
General supervision and repairs	500
Total	$5,270

The cost per ton of coal delivered to the storage yard, including delivery of the coal from storage to the power plant, thus amounts to 17.6 cents per ton. This plant was designed to handle approximately 60,000 tons of material, so that when the crane is operating to capacity, the cost of handling per ton will be reduced to a still lower figure.

Replacing Cables on a Two to One Traction Elevator Machine

A method that has been used successfully for a number of years in cabling two to one traction elevator machines is described in detail. This plan eliminates much of the hard work that is generally attendant with such jobs.

By F. A. ANNETT, Associate Editor, *Power*

IN REPLACING the cables on elevator machines the procedure will differ with the type of machine and the men doing the job. Also the amount of hard labor that is necessary depends to a large degree upon how much thought is given to doing the job before beginning the work. Of course, when cables are replaced by repairmen from the manufacturers or a contracting company, they probably cannot avail themselves of the conveniences that the repair crew in a large plant can. The method of replacing elevator cables described in this article applies particularly to the latter, although it may hold some good suggestions for transient repair crews. The scheme has been applied to roping up traction machines having two to one roping, and was devised by L. Botsford, formerly chief engineer, Mc-Graw-Hill building. In the one to one roped machine the cables pass directly from the car over the traction sheave, around the idler sheave, back over the traction sheave and to the counterweight, as in Fig 1. With this arrangement the car and counterweight speed is the same as that of the cables. With two to one roping one end of the cables is dead-ended to the overhead work, passes under an idler sheave in the car crosshead, then up around the idler and traction sheaves and down around an idler sheave on the counterweights, back to a dead end in the overhead work, as shown in Fig. 2. With this arrangement the car and counterweight speed is only one-half the rope speed. This allows operating the motor at double the speed, on the two to one, of that on the one to one machine for the same car speed, which greatly reduces the dimensions and weight of the motor and results in a considerable reduction in cost.

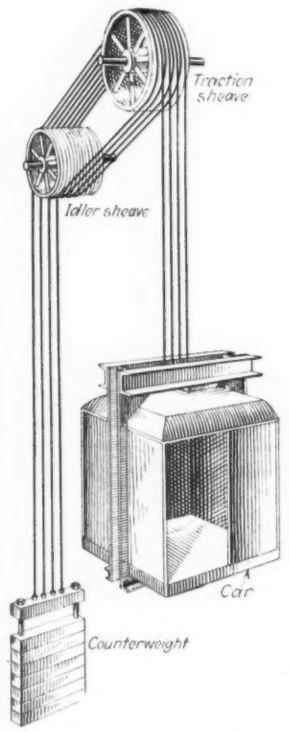


FIG. 1—TRACTION ELEVATOR WITH ONE TO ONE ROPING

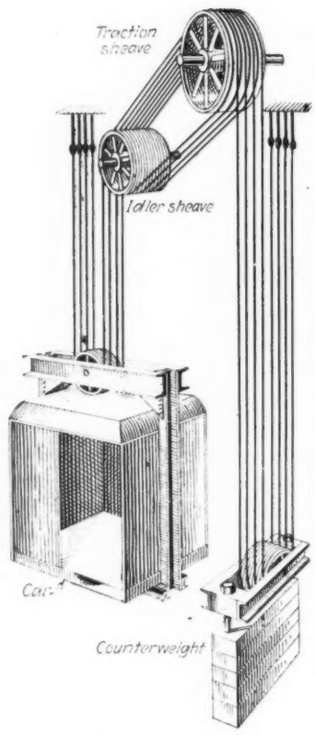


FIG. 2—TRACTION ELEVATOR WITH TWO TO ONE ROPING

When the first machine is roped up, considerable preliminary work is necessary, but after that this material is always available. In high buildings the cables are long and heavy; this is particularly true of the two to one traction machine, since the ropes are almost twice as long as for one to one roping. One of the first essentials is some means of handling the cables. This has been solved in one case by mounting two shaft hangers on a platform as shown in Figs. 3 and 4. In use this platform is bolted to the floor of one of the industrial trucks in the plant, thus making it easily moved

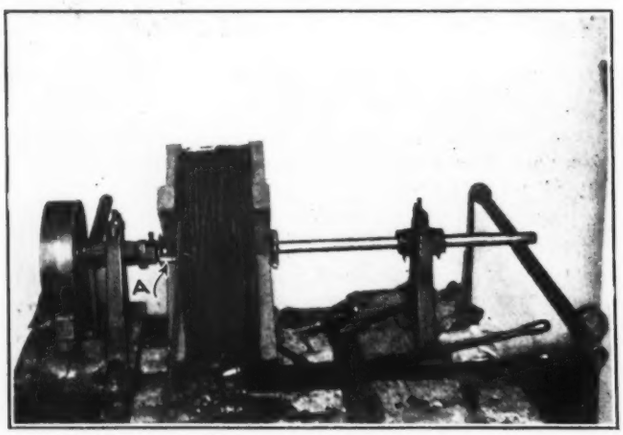


FIG. 3—CABLE REEL IN PLACE ON SHAFT READY TO RUN ON CABLE

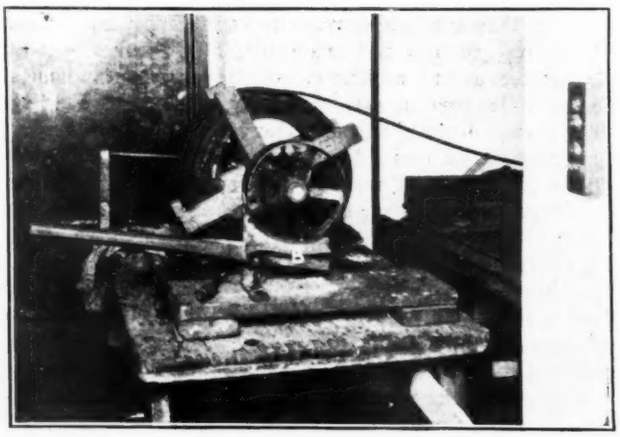


FIG. 4—BRAKE *B* IS USED TO CONTROL SPEED OF CABLE OFF THE REEL

about. A shaft about 5 ft. long with an ordinary 15-in. iron pulley secured to one end is used to mount the cable reel on. The reel is held in place on the shaft by two lathe dogs, the tails of the dogs being placed between the arms on the reel, as indicated at *A*, Fig. 3. The shaft and reel can be easily lifted by two men and placed in the bearings, after which the caps are screwed down. To control the rate at which the cable can unwind, a brake is provided on the pulley. This brake consists of a wooden lever mounted on an iron bracket, as indicated at *B* in Fig. 4. The braking end of the lever is faced with leather to increase the friction.

To support the cables while the replacements are being made, two planks are placed across the counterweight guide rails above the top of the car, as shown at *A*, Fig. 5. These planks rest on the guide-rail supporting brackets, one plank on each side of the rails, held together by one bolt. On top of these planks is placed a piece of 3-in. square iron about two ft. long. In this piece are drilled twelve holes for six U-bolts, as shown in Fig. 8, which were made up of ⅜-in. material. To support this clamping device on top of the planks a piece of ½x3-in. iron ten inches long is bolted on each end of the clamping block. This clamping block is placed on the cables between the counterweight and traction sheave, as indicated in Fig. 12.

A special pulley made of 1x4-in. hardwood and a sheave is used to support the cables when they are being run on. The pulley is left open on one side, as indicated in Fig. 7, so that the cable may be placed on the sheave without running the end through. On the long side of this pulley is bolted a piece of iron to support it in the elevator shaft as indicated at *X*, Figs. 5,

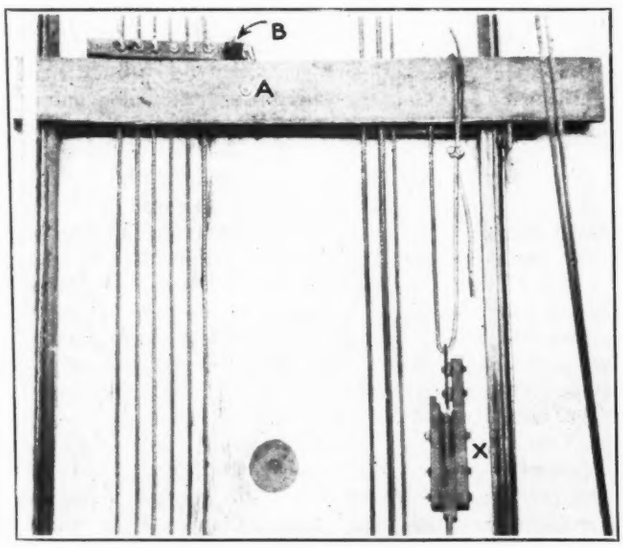


FIG. 5—CLAMPING DEVICE IN PLACE ON COUNTERWEIGHT CABLES

6 and 12. The foregoing and an ordinary bench vise include what must be provided before starting the job.

At some convenient time before beginning the work of putting on the cables, a loop should be made on the ends of each new cable, so as to fasten the old cables to them, when the former is being run on and the latter off. This loop must be made good and secure so that there will be no danger of its pulling out when the cable is being run on, since this would allow the old cable to drop into the shaft, which might injure someone at the bottom of the pit. The loop must also be made small so that the cable will run between the sheave and the cable guards. A method that has proved successful is to first serve the cable with small iron wire at about 9 in. and 15 in. from the end. Then take off the end serving and cut three of the six strands out of the cable at the second serving. The three strands to cut out are those indicated at 2, 3 and 6 in Fig. 9.

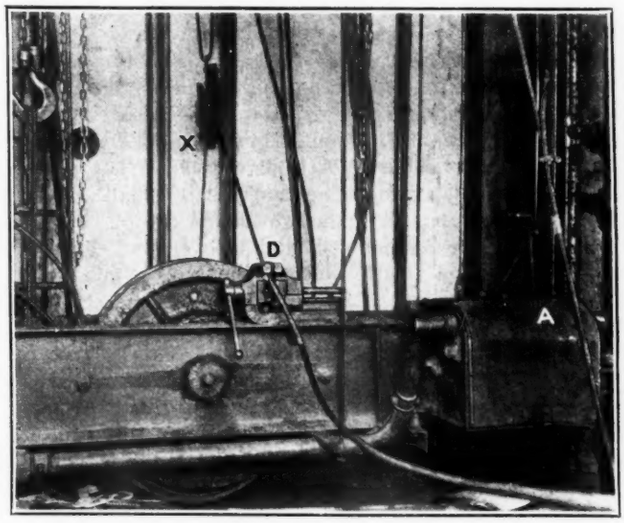


FIG. 6—NEW CABLE MARRIED TO OLD ONE, READY TO BE INSTALLED

Nos. 1 and 4 are left complete, and all the wires are cut out of No. 5 with the exception of 2, Fig. 10. The second serving is now removed and No. 1 strand is cut off back to the last serving, Fig. 11, and No. 4 bent back into the space left by No. 1 so as to form a loop on the end just about large enough for one strand of the cable to pass through. The two wires that are left in No. 5 are now wrapped about the end of the cable so as to get a good smooth job and not to have more than one layer of wire in one place. After these two wires are wrapped on, then one wire at a time is taken from the bent-back end of No. 4 and wrapped around the cable; this is done until the wrapping extends back to near the serving. Then the remaining wires of No. 4 strand are cut off and the wrapping is covered with one layer of friction tape, which is also put on about six inches of the end of the cable back of the serving. If this job is properly done, the end of the cable will be smooth and the loop will hold any strain it may be subjected to when putting on the cable.

The first step in replacing the cables is to bottom the counterweights and support the car from the overhead work. The counterweights are best supported on two 3x4 or 4x4 timbers, one placed at each side next to the guide rails. Of course a clamping device may be made to fasten around the guide rails at the point where it is desired to land the counterweights, which should be supported at a height to allow the top of the car to come about level with the top-floor landing. If care is exercised, the counterweights can be landed with little shock by operating the machine with its own power, after which the main-line switch on the controller should be opened.

After the counterweights have been landed, the car

must be raised about two feet, high enough to give sufficient slack in the cables to clear all sheaves. This is done with two one-ton chain falls, one attached to each end of the car crosshead. When the car has been raised enough to take the tension out of the cables, the clamping device, Fig. 8, is put on the cables, as shown at *B*, Figs. 5 and 12, after which the hoisting of the car is completed. In this way practically all of the slack in the cables is retained around the traction and idler sheaves. After the car is lifted, the cables are tied up from the sheaves so as not to rub in the grooves when running on a cable.

The machine is now ready for putting on the cables. A sling is connected around one end of the plank on the counterweight guide rails and the pulley described in Fig. 7 put in place. This pulley is shown at *X* in Figs. 5, 6 and 12. The cable truck is placed across the hoistway door against a timber, so that it will not be pulled in against the car. The guard over the top of the car crosshead sheave is removed, and into one of the bolt holes is fastened a vise to hold the cable on which work is being done. The guard on the under side of the crosshead sheave is also removed.

To provide control of the machine from the top of the car, the car switch is tied all the way over in a position to give the correct direction of travel to run on the cables, and the spring removed from the arm on the limit switch on top of the car. This switch is shown at *A*, Fig. 6. All the magnetic switches, with the exception of one direction switch, are blocked open, and the

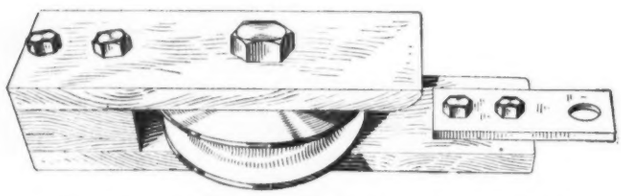


FIG. 7—PULLEY USED IN PUTTING ON CABLES

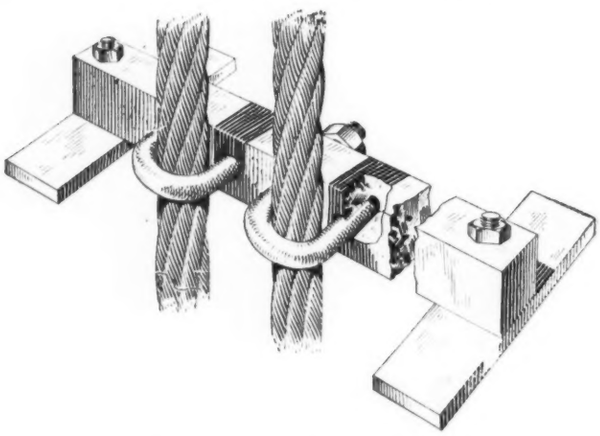
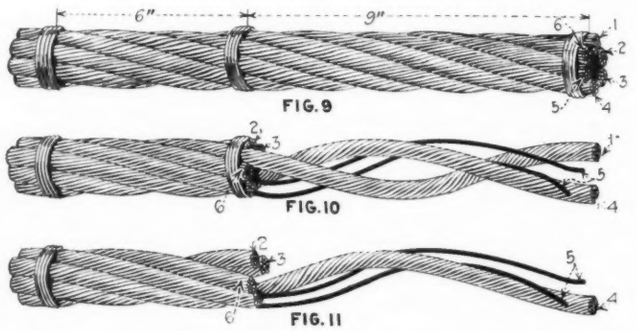


FIG. 8—COUNTERWEIGHT-CABLE CLAMP

main-line switch closed. Then, by manipulating the limit switch on top of the car, the machine may be started and stopped at will, and as all the accelerating switches are blocked open, only the slowest speed can be obtained.

Now all is in readiness to begin putting on the cables. Clamp the first cable to be renewed to its neighbor, placing the clamp at any convenient point below the shackle on the counterweight end, as at *A*, Fig. 12. Then the shackle is released from overhead and the end of the cable lowered down on top of the car. The shackle is removed and the end of the old cable married to the end of the new one, a loop already having been provided on the end of the new cable, as previously described. To connect the old cable to the new one, a strand is taken out of the former for about six feet from the end, and cut off. Four of the remaining



FIGS. 9 TO 11—SHOW METHOD OF PUTTING LOOP ON END OF NEW CABLES

strands and core are cut off about three feet back; this leaves one strand about three feet long. This strand is passed through the loop in the end of the new cable up to within about three inches of the old one, and the strand wrapped back into the space left by removing the one cut out. After this has been done, the end is covered with a layer of friction tape. This connection has been used in replacing a large number of cables and has never failed.

The cable is now laid into the pulley shown at *X*, Fig. 6, drawn tight by hand and gripped in the vise shown at *D*. The shackle is removed from the other end of the old cable and removed from the sheave in the car crosshead. A bag of cement or other convenient weight is then tied to this end of the cable and lowered over the side of the car where it is decided to allow the old cable to run into the pit, as indicated in Fig. 12. Previous to this the cable has been lowered onto the traction sheave. The cable is released from the vise on the car crosshead, and the clamp is removed that holds it to one of the other cables, and the machine started from the limit switch. The travel of the new cable will be down the shaft, around the counterweight sheave, then up the shaft, over the traction sheave, around the idler sheave and back down to the car. When the connection between the two cables arrives at some convenient point on top of the car, the new cable from the reel is again gripped in the vise, the remaining cable on the reel removed by hand and the shackle placed on its end, after which the cable is fastened in place, released from the vise and the slack allowed to drop down the shaft. The end of the old cable is now gripped in the vise, the machine started and the slack of the new cable pulled over, after which the new cable from the counterweight is fastened into clamp *B*, Fig. 5. The new cable is now cut free from the old one, put through under the crosshead sheave, cut the proper length, the shackle placed on its end and put into place. The new cables should be cut about one foot shorter than the old ones to allow for stretch. This one cable is put on completely, as a safety measure. Only the counterweight ends of the other cables are put in place as the cables are put on, and the car ends are allowed to hang

down the shaft until all the cables have been run on, then these ends are put into place.

The second cable is put on in the same way as the first. The car end of the cable is taken down, the shackle cut from it and this end connected to the old cable in the vise and then allowed to hang free down the shaft. Then the counterweight end of the old cable is taken down, as for the first one, the new cable fastened to it and run on, and the counterweight end put in place as for the previous cable, after which the slack is dropped down the shaft and pulled over to the car end and allowed to hang loose until all the cables are in place.

Care should be taken to keep the cables straight so that there will be no danger of getting the new ones crossed. This is easily done by tying a long, heavy cord to the first cable put on, down near the counterweight; then when the next cable is in place, it is tied to the first with the same cord, so that when all the cables are in place it will be known exactly where each belongs. It is also good practice to do the same up on top of the traction sheave. After No. 1 cable has been run on and when lifted off the sheaves, a cord is tied to it and this is turned to the other new cables as they are run on and lifted off the sheaves to allow the others to be run on.

There are numerous small details of the work that each crew putting on the cables will have to work out

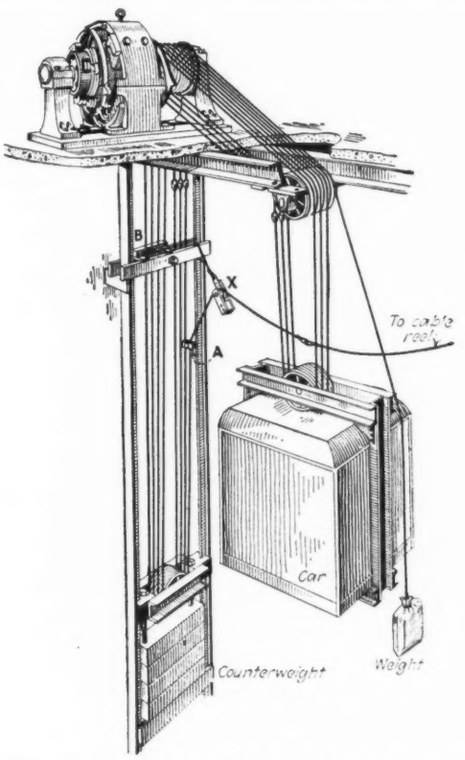
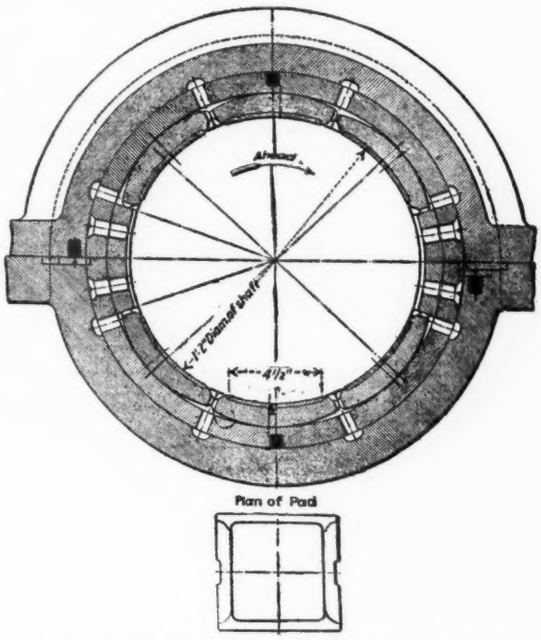


FIG. 12—FIRST NEW CABLE READY TO BE RUN-ON, WHEN CLAMP *A* IS REMOVED

for themselves, but with a little practice they can eliminate the real hard work to a large degree. Using the method described in the foregoing, two men who knew the work, with a helper, completely cabled a two-to-one traction machine, having six cables operating in a fourteen-story and basement building, in one night, working from 6 in the evening until 8 o'clock the next morning, a total of 14 hours.

Turbine Bearing Composed of Self-Aligning Pads

The first marine turbine installation equipped with Michell type combined journal and thrust bearings is described in *Engineering* (London), of July 28, 1922. The journal bearings are comparatively novel, consisting of a number of bearing pads surrounding the shaft which are contained in a housing, with which they form



ALIGNING PADS CONTAINED IN HOUSING

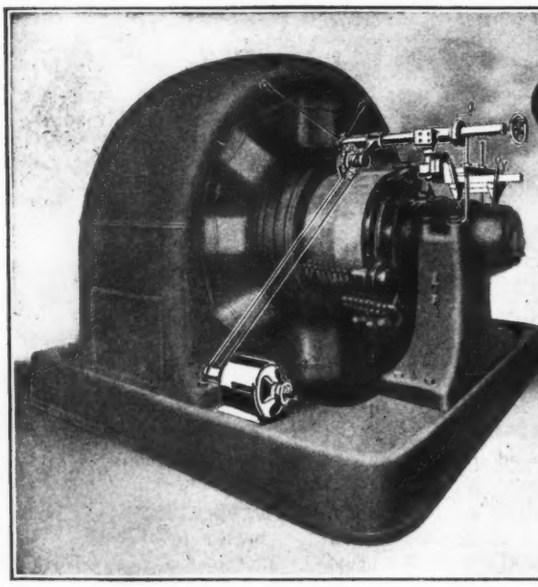
a line contact, permitting them to rock. When the shaft is revolving, a wedge-shaped film of oil is forced between the shaft and pads causing them to take a slightly inclined position to the shaft surface, with the greater clearance where the film enters each pad.

Ports for oil are introduced between each pair of pads, so that oil under pressure is admitted through a recess in each pad.

A 14-in. diameter journal is illustrated, containing six self-aligning pads, each 4½ in. wide, and 4⅛ in. long on the babbitt. The upper three pads touch each other and are prevented from rotating by a solid stop piece at the right of the housing. The lower three pads are driven by friction against each other, in the same way, the leading pad being held by the stop piece to the left.

The bearings are thus reduced approximately to one-third of their original length. They are designed for 550 lb. per sq.in. of projected area, with a surface speed 76.5 ft.-sec.

With 40 per cent normal volts impressed on the stator terminal, a polyphase induction motor will take approximately 100 per cent normal full-load current and develop about 30 per cent full-load torque; at 60 per cent normal volts, 250 per cent full-load current and develop 52 per cent full-load torque; at 80 per cent normal volts the current will be approximately 400 per cent and the torque 125 per cent; and at 100 per cent normal volts the current will be 600 per cent and develop about 200 per cent full-load torque. However, this varies somewhat with the design of the motor and should be taken only as approximate.



Grinding Commutators and Collector Rings—Preparations for Grinding

By Eustis H. Thompson*

TRUING commutators by means of a turning tool has been gradually giving way to the more modern method of using a revolving grinding wheel. This is better suited for undercut or high-speed commutators. The points of advantage in general are as follows:

1. Grinding with a revolving wheel will not drag copper over the edges of the bars so as to bridge over the slots where the mica has been undercut as a turning tool is very likely to do.

2. Surfaces that have been turned true at low speeds often run out of true to some extent at high speeds, owing to centrifugal forces of the revolving element. Grinding can be done at full speed, which will thus take care of all deflections and produce a surface that is true at normal speed.

3. The surface produced is of such a durable character that the brushes will not "pick up copper" as commutators often do if turned with a tool at high speed, owing to the soft character of the surface produced.

4. The operator is not subjected to the risk of having the tool "dig in"; the wheel may cut deeply if an accident occurs, but it would not be at all serious in comparison with the gouging effect of a tool.

5. The operator is not required to exert the skill and care necessary in grinding and setting a tool.

6. It is not necessary to mount the grinding machine with the same degree of rigidity required in a turning device.

7. The trouble of working at low speed, which often involves special methods of rotating the generator, can be avoided by grinding at the normal speed of the prime mover.

8. Since the grinding wheel is itself an insulator for five hundred volts or more, it is much easier to grind a commutator while the machine is under voltage than to use a turning device on which the tool must necessarily be insulated.

9. Collector rings are sometimes made of such hard material as to be difficult to turn with a tool, and in such cases a grinding wheel is a great convenience.

10. In close quarters or difficult places to reach with a tool, it is sometimes possible to operate a grinding device more conveniently.

11. When undercutting the mica of a large commutator by methods devised "on the job," it sometimes happens that the bars, especially where speed is important, are badly disfigured and a great deal of finishing becomes necessary; in such a case a grinder is a quick and convenient means of smoothing up bad jobs.

12. On account of less rigidity being necessary, it is often possible to mount a grinding device by removing one or two brush studs, whereas a turning tool would require a greater amount of disassembling.

Disadvantages are as follows:

1. Large commutators with full mica, as on low-speed machines, can sometimes be turned more quickly with a tool if there is a large amount of copper to come off.

2. Grinding devices make more dust, due to finely divided copper and the material of the wheel, than a turning tool, and this is scattered over a much larger area so that greater precautions must be taken in order to protect the machinery.

3. Since a grinding wheel tends to wear round corners, it is not possible to bring the finished surface close up to the "necks" or "risers" or "conductors" of the commutator bars as can be done with a turning tool. This, however, is a detail of small importance.

4. The finished surface may contain low spots if the operator is not careful in doing the work, with a wheel, or if the bearings are allowed to have lost motion or if vibration of the wheel occurs. These troubles are not difficult to overcome.

In truing a commutator by means of a turning device, the skill and care of the operator are directed chiefly in obtaining a rigid mounting, grinding and setting of the tool, pre-

GRINDING with a revolving wheel is compared to turning with a tool. Dust can be prevented from entering machines by effective and convenient methods worked out in practice. Subsequent articles deal with mounting and operating various types of grinders.

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venting the point from "digging in" and in making a smooth finish. On the other hand, a grinding device does not require such a rigid mounting or delicate adjusting and handling as a tool, but the principal part of the job consists in making the generator dustproof and in figuring out the right arrangement for mounting to the best advantage with proper driving speed.

The plan of procedure in grinding is to figure out in the first place the details of disassembling the generator as much as is required, together with the best

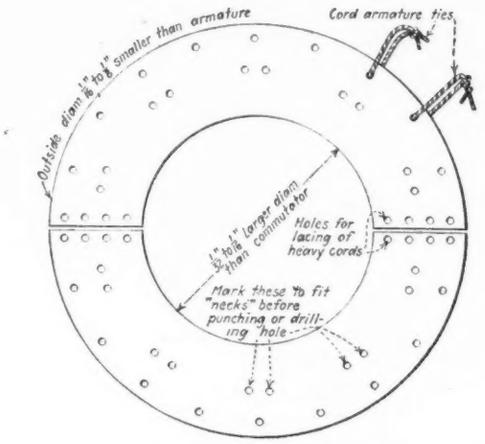

Cord armature ties
Outside diam ⅛" to ¼" smaller than armature
½" to 1" larger diam than commutator
Holes for lacing of heavy cords
Mark these to fit "necks" before punching or drilling hole

FIG. 1—"SCREEN" OR "HEAD" OF $\frac{1}{16}$-IN FIBER LACES ON END OF ARMATURE; CAN BE MADE IN TWO OR MORE SECTIONS

arrangement for mounting the grinder. Make the generator dustproof, mount the rigging, adjust the speed, feeds, etc., and then bring the machine to speed and to the grinding itself, which is usually about one-fourth of the whole job in actual time consumed. Cleaning and assembling, after completing the work, follow in natural order.

Dustproofing Generators

Finely divided dust from a grinding wheel penetrates bearing caps, oil guards, ventilating ducts and many places where least expected. The air currents often draw this dust into the windings and insulation of a machine. If the operator blows out the machine with compressed air and feels assured of protection by the clouds of dust produced, he is likely to be misleading himself. Dust from the wheel is quite easily removed by this means, but copper dust is too heavy to be eliminated from confined or remote lodging places by compressed air. Wiping with a cloth is better, but preventing the dust from reaching critical points is the surest and easiest course to pursue.

The question of protecting against dust is not always viewed in the same light. One concern which has ground commutators for many years advises that such precautions are unnecessary and that they have never had trouble from copper dust. With the average slow or medium-speed machine, careful wiping may produce satisfactory results. On the other hand, cases of "grounding" due to copper dust have occurred where everything had been scrupulously cleaned. One of the largest manufacturing companies eventually required very careful dustproofing of armatures which were grounded in the power house or mill.

The operating engineer will undoubtedly feel justified in protecting against dust if he takes the trouble to examine the bearings of a machine that has received several hours of grinding. Removing the rotating element of an alternating- or direct-current machine will reveal the extent to which copper dust penetrates, from which removal is often impossible with the machine assembled. On many machines the insulation would prevent trouble, and steel dust or other conducting material is regularly absorbed in the usual operation of machines in some mills, so that copper dust would not produce alarm. First-class operation, however, usually hinges on taking precautions, and the presence of copper dust is not viewed with favor as a rule.

The problem of dust protection presents widely varying conditions. In emergency cases it may be necessary to true a commutator while the machine is carrying load, and with little opportunity to apply protective measures.

Slow-speed machines, especially of the older type, usually produce less suction of the ventilating currents than higher-speed or more modern types.

Some armatures are naturally better protected from dust when the spaces between the "necks" or "risers" which connect the commutator bars to the windings are filled with insulation, so that no dust can penetrate the interiors of the armature than in the case of open spaces between the "end conductors" or "necks," where ventilating air would draw in the dust. There is much less suction from the ventilating currents when the machine is ground at a speed considerably below normal.

Methods of Dust Protection

Methods of protecting against dust include blowing the dust away from the machine with compressed air, collecting that thrown out by means of a vacuum attachment and placing stationary or revolving screens about the machine to protect against dust. The first method

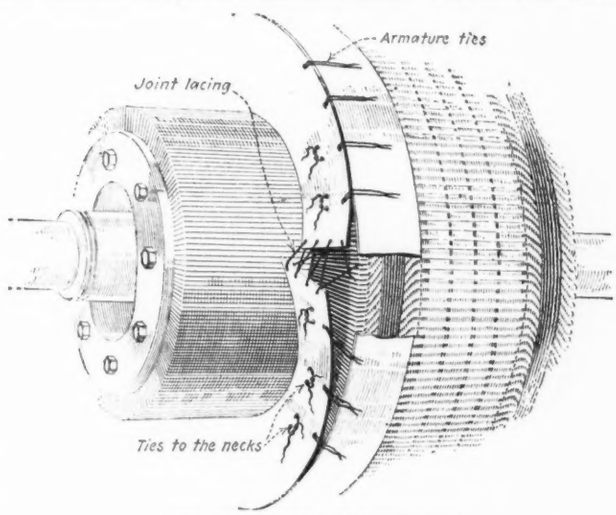


FIG. 2—TYING THE SCREEN

Cord is preferred, but wire may be more convenient for tying to necks. Do not short circuit two necks with wire, but tie over one only at each place.

is sufficient only where little or no actual protection is required; the second method is often used with success, but the last is the most dependable and can usually be applied easily and effectively. Revolving screens are necessary when strong air currents enter armatures. Stationary screens are more convenient and suitable for low-speed armatures generally and are naturally adapted to the protection of stationary parts.

In grinding commutators at full speed, it is often

difficult to make canvas or paper stay in place on a revolving armature at normal speed, especially with high-speed machines. A screen for keeping dust out of the armature that can be made sufficiently strong to withstand 3,600 r.p.m. is illustrated in Fig. 1. This is made of ⅛-in. fiber with holes punched at the joints

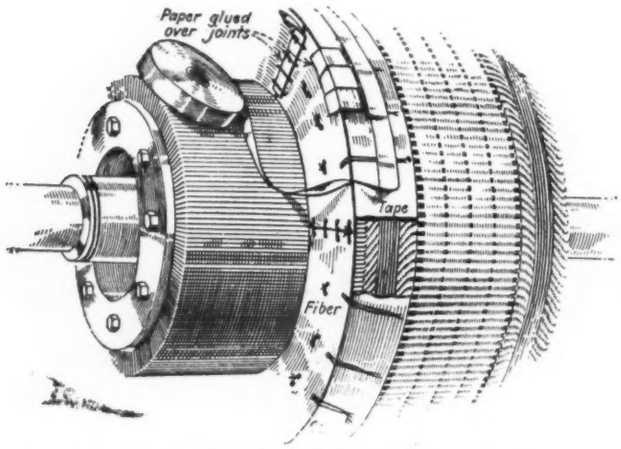


FIG. 3—FASTENING ARMATURE TIES WITH FRICTION TAPE

A double layer extending ½ in. over edge of armature winding should be placed on first. Lay ties over this and fasten with an outer layer of tape.

for lacing the two halves together. The inside circle should be 1/32 to 1/16 in. larger in diameter than the commutator itself. The outside diameter should be ⅛ in. smaller in diameter than that of the armature. The reason for making this smaller is that armature ties can exert a radial pull and help hold the screen flat.

Fig. 2 shows how this screen having ties to the "necks" or "end conductors" should be placed on a machine. These ties are for the purpose of keeping the fiber flat against the conductors, as otherwise it would tend

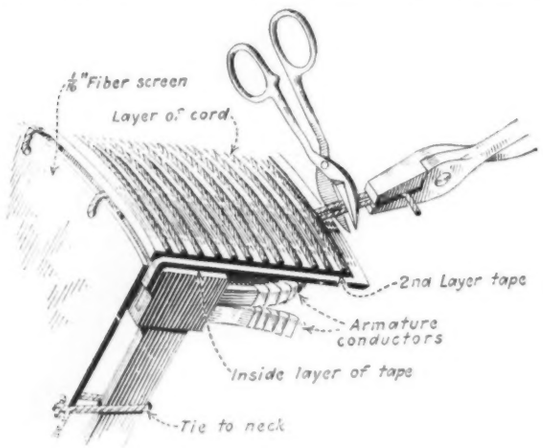


FIG. 4—SECTION THROUGH SCREEN SHOWING TIES

Pull armature ties tight with pliers and cut close with shears. Make screen lie *flat* against necks.

to bulge out in places and prevent the grinding wheel from traveling as far in this direction as it otherwise would. These ties should be of strong cord or heavy wire. Small wire is objectionable as it may break off inside of the armature and be very difficult to extract. No. 14 wire or larger is good, but cord is best. These holes can be punched to better advantage by marking the fiber after it is in place on the commutator, so that they will match up exactly with the risers from the bars. If it is desired to save time, the holes can be punched wherever thought best, with several extra sets as well, so that if the holes do not match properly in one place, those of another place can be used to better advantage. These ties should be from three to five inches apart.

Tie pieces for another purpose are shown in Fig. 3. The holes for these ties should be punched one-half inch from the outer edge and two to three inches apart. They also help to pull the fiber flat against the risers. In order to fasten these, a layer of tape is wound around the armature conductors and several more layers wound over this. The end ties are now placed over the tape as another layer is wound around over the ties to hold them in place. Enough tape is added to cover them well, and several layers of strong cord are placed over the tape. Each tie is then pulled tightly by means of a pair of pliers, and cut off close with shears, Fig. 4. These ties will tend to pull the screen away from the

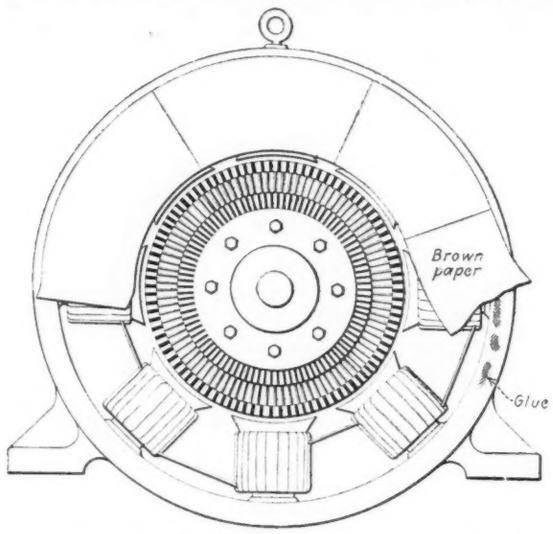


FIG. 5—COVERING FIELD WINDINGS WITH STATIONARY SCREEN OF PAPER AND SHELLAC OR GLUE

commutator and keep it flat against the risers. Loose ends should be cut off.

Fig. 3 shows how this can be made dustproof by covering the joints and other openings with paper fastened by means of shellac or glue. Strips of paper can also be taken over the outer edge and fastened on the armature with cord, if necessary. Most armatures, however, can be made tight without paper at this point. If it is desired to omit this armature paper, the first two layers of tape can be made to extend over the edges of the end conductors ⅛ in. so that the screen will be pulled up against them tightly so as to keep all dust out at this point, as in Fig. 4.

The spider of the commutator should be made dustproof by means of a similar screen or else by stuffing in rags. It must be remembered that copper dust flies in every direction and should be provided against at every point. It is much easier to protect windings and other delicate points against this dust than it is to clean this off afterward.

The rear end of the armature, or in other words that away from the commutator, should be protected in the same manner in order to prevent dust being drawn into the ventilating ducts. This is not always a vital matter, but should nevertheless be attended to in order to play safe.

Fig. 5 shows an easy way to protect the field windings against dust. Brown paper should be held in place by shellac or glue so as to cover the field windings, etc. Tarpaulin or canvas can be used if more convenient, tied on.

In the case of a low-speed generator it is not necessary to go to the elaborate arrangements before described. The armature can often be protected by means of stationary pieces of fiber, pasteboard, or heavy fish paper, etc., which bear against the commutator as shown in Fig. 6. Fig. 7 shows convenient protection of a small motor. This method is much easier and quicker, but is not suitable to high speed apparatus where there are strong air currents.

Copper and dust from the wheel is often found in the bearing casings after grinding a commutator, unless these have been protected. A collar of cloth or felt can be placed around the shaft close to the bearing. If the bearings are fitted with good felt collars for oil

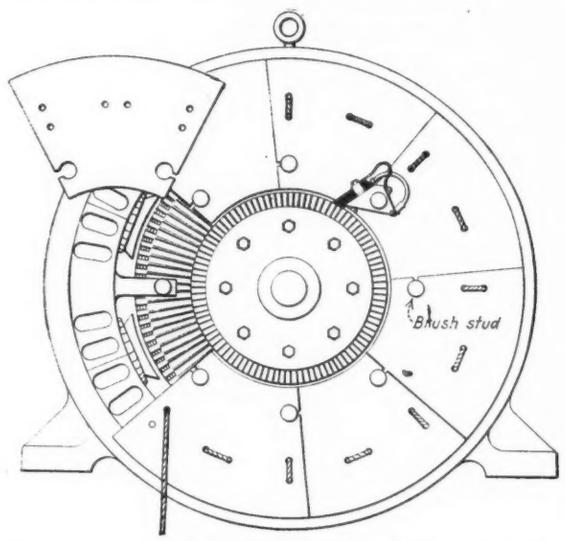


FIG. 6—SCREEN OF CARDBOARD CONVENIENT FOR ENGINE-TYPE GENERATOR

deflectors, this will not be necessary. It is advisable, by all means, to cover up the caps for looking at the oil rings. Grit often works into such places without being realized.

In case of collector rings it is advisable to protect the bushings on which the rings are mounted, as copper dust is very likely to settle under these bushings where it cannot be cleaned away. Large induction motors frequently have starting voltages of 700 volts or over at these rings. Rags can be worked between these rings and tied with cord and tape.

When an induction motor runs at full speed, there is usually a strong current of air being pulled into the machine at the shaft. Making such a place dustproof is illustrated also in Fig. 8. A stationary screen of wood and fiber is built across the end of the motor so as to come very close to the shaft. A collar is made of fish paper with slits cut in one end so that the strips are pulled away from the shaft by centrifugal force and form a collar to prevent copper from getting between the shaft and screen.

In order to cut this draft down further, the ventilating holes in the frame of the motor can be stopped up with rags or paper. The end of the motor away from the grinder can be protected with a screen. Sometimes this is far enough away so as to make a screen unnecessary.

When grinding the collector rings of an alternating-current generator such as a turbo-alternator with end shields close to the shaft, a felt collar can be used to advantage to prevent dust going in. Bearings should

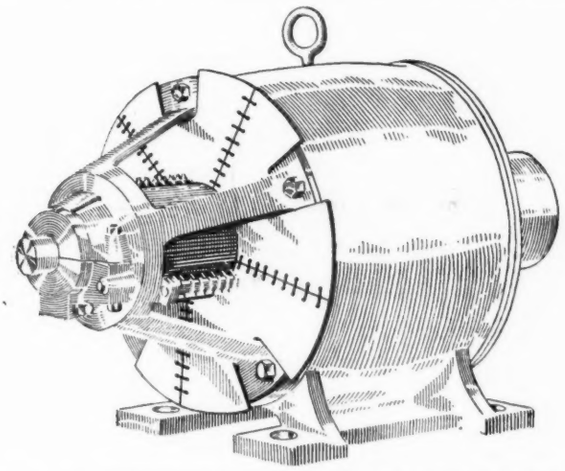


FIG. 7—STATIONARY SCREEN FOR SMALL MACHINE EASILY MADE

be protected in long grinding jobs by a felt or rag collar around shaft. Oil caps, etc., should be covered with canvas or heavy paper.

An induction motor with wound rotor is inherently well insulated, so that copper dust is not necessarily harmful. The surge in starting a high-voltage machine is always an undesirable strain, however, on the insulation of both stator and rotor, and copper dust might easily work into

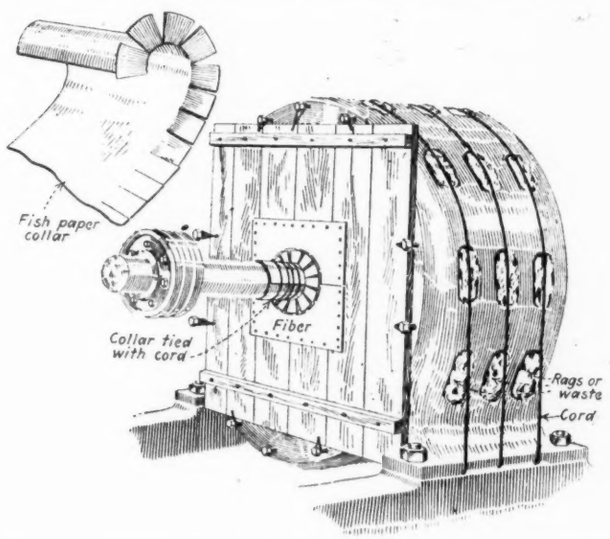


FIG. 8—SCREEN OF BOARDS, FIBER AND REVOLVING COLLAR QUICKLY PLACED ON LARGE INDUCTION MOTOR WHICH WAS GROUND AT FULL SPEED. REVOLVING FISH-PAPER SHAFT COLLAR

some crevice where insulation had become weakened or cracked, and help to form the path of an arc. Care of electrical machinery, when efficiently given, is an expenditure yielding far better return than lack of attention or desire to avoid work. Each case, however, is governed by its own conditions, in that a general rule may be helpful but it is not necessarily applicable to every case

Departure in Boiler Settings

By Michael Liptak

Progress in power-plant construction has been tremendous. Prime movers, generators, boilers, condensers, piping, feed-water treatment and other features of power-plant design have advanced in leaps and bounds, and today the modern power plant is a marvelous structure compared with that of twenty years ago. These tremendous strides are the culmination of co-operative effort between the designing engineers and the manufacturers of power-station apparatus and appliances.

There is one item of power-plant construction, however, which has greatly lagged behind: namely, brick boiler settings. This may be due to the fact that a boiler setting is not a manufactured article and the co-operation of the manufacturer was not to be had. boiler setting. The result was that the boiler mason who was not co-operatively inclined did not give his best efforts to the job and the resulting construction usually was far from satisfactory.

The cause of these unsatisfactory results cannot be laid to the brick mason or superintendent of construction or foreman on the job, but should be laid at the door of the designing engineer, whose progress in this particular field has lagged behind the other features of power-plant design. Not only in the design, but in the specifications, has there been a certain laxity. Simply specifying that the wall shall be built with five headers and a stretcher course, or every sixth course a header course, is not sufficient information to give to a boiler mason and expect a first-class job.

The greatest difficulty with the building of a boiler setting where a combination of firebrick or common

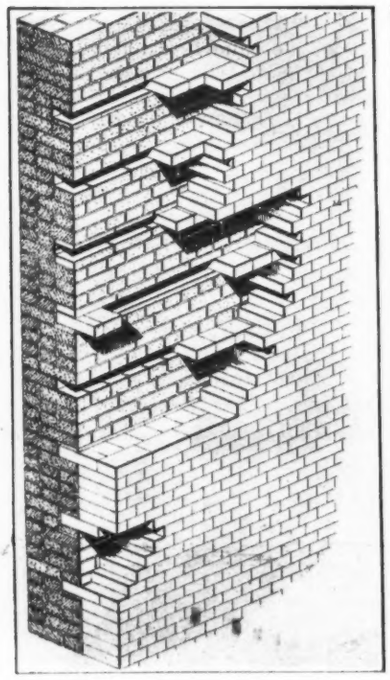


FIG. 1—FURNACE SIDE WALL AS COMMONLY CONSTRUCTED

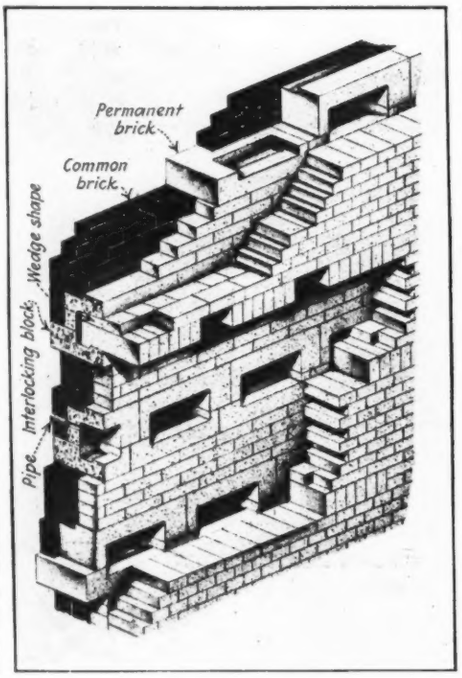


FIG. 2—LIPTAK INTERLOCKING FIREBRICK WALL

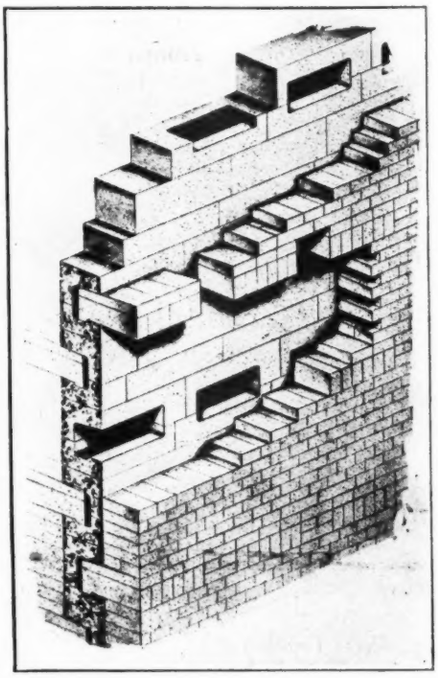


FIG. 3—LIPTAK METHOD OF BUILDING DIVISION WALL

Progress in the use of powdered coal and high ratings in stoker-fired boilers is being retarded not only because of limitations of the present-day refractories, but greatly more due to the present-day methods of using these refractories in the building of boiler walls and inclosures.

During eighteen years of specialization in the construction of boiler walls, the writer has found the specifications to be practically identical in all cases, the variation being in the header and stretcher clauses. Some specifications call for each fifth or sixth course to be a header, others call for all headers except occasional stretcher courses, and occasionally a relieving arch was specified. Each designer or his superintendent of construction (and the work done included that of some of the foremost designers of the country) had his particular instructions to issue to the mason on the job, but the engineers or the superintendent of construction did not always have specialized knowledge of masonry construction, particularly in the line of brick is used, is in the varying sizes of common brick and firebrick, and further that the joints on common brick are of a different character from those on the firebrick, the firebrick having practically no joint. The result is that the inequalities are taken up by a splash of mortar which, when the wall becomes hot, disintegrates rapidly into a fine powder and its binding qualities become nil. As a consequence of this disintegration the walls lose their structural qualities, the bricks separate and the walls bulge.

A number of changes were made in the accepted method of construction of boiler walls, but all without success. In the old type of wall, when repairs were attempted and the burned-out firebrick was removed the new firebrick never could be replaced so as to occupy the same space as the old. Consequently, the entire weight of the wall was imposed on the outside common-brick lining.

The writer believes that the shortcomings of the common boiler wall are overcome by the interlocking

wall, illustrated in the accompanying drawings. The new wall is structurally strong, permits of rapid repair at any point, avoids mortar pockets and wall bulging, and will permit of longer periods of boiler operation than the old-type design.

The wall is interlocked without the use of metal, all interlocking being done with refractories. The lay-up of firebrick and common brick is such that the firebrick joins in fairly, resulting in a wall that is structurally strong and, what is of the greatest importance, permitting a clear-cut specification and design which can be followed by any intelligent bricklayer.

The construction of the new wall is shown and an opportunity for comparison with the old-type design afforded by the accompanying illustrations, which are self-explanatory. Fig. 1 shows a furnace side wall as commonly constructed and Fig. 2 the new interlocking wall. The interlocking blocks, the specially shaped bricks fitting into them and the wedge-shaped bricks to hold them in place, are plainly shown. The 1-in. pipe, shown in the foreground passing through the common brick wall and the interlocking block, has been provided to facilitate the removal of the wedge-shaped brick. With a bar, common labor on the outside can drive out these bricks instead of leaving their removal from the inside of the furnace to the mason whose time is more valuable. From the construction it will be appreciated that any part of the firebrick lining may be removed without disturbing other sections of the wall. Fig. 3 shows the new Liptak method of building division walls.

Objection may be raised to the special firebrick required. It is to be noticed, however, that there is only one special shape that will need replacement. The other three are required only in the original construction. These can be manufactured by any brick manufacturer at a small cost over that of the regularly shaped firebrick. When the two walls are contrasted with the common designs of wall illustrated, and the points of merit appreciated, it will be seen that the additional expense is more than warranted because of the low cost and the ease of making repairs.

Locating Knocks in a Steam Engine

By Thomas W. Airey

Malalignment as a general rule is induced by wear or incurred during repairs and adjustments made to the various parts of the machinery. The chief parts affected are the pistons, cylinders, guides, connecting rods, crankpins and the crankshafts. Thus by adjusting the crosshead slippers to take up the wear in the guides, the cylinder may be affected. The crosshead guide and the cylinder may be affected by repairs to the connecting-rod brasses and the connecting rod and crankpin may also be affected by repairs to the main bearing brasses. Sometimes a knocking is very difficult to locate. You may imagine the connecting-rod bearings are the cause and may grasp the connecting rod firmly for several revolutions, or you may lay your hand on the main bearing; the guides may next receive your attention; then on to the cylinder, and yet you may fail in locating the knock. As a final test you may take the steel rule from your pocket and holding it between your teeth rest the other end on the crosshead guide, then on each of the cylinder and the main bearings, repeating the operation at each particular place so that the sense of feeling may indicate the knock. In most obstinate cases, however, the knocking is most likely to be located by using a piece of steel wire, one end of which is taken between the teeth while the other end rests on the point of observation. As this test depends on the sense of feeling, everything including the hands, must be kept clear of the wire so as not to retard or deaden the vibration transmitted along it. We will suppose that we have located the knock, which is in the cylinder; the cylinder cover is taken off and the piston drawn out and examined and found to be all right, but we find that a ridge has formed at the end of the cylinder bore. The ridge is trimmed off, the piston put back and coupled up again. Now it is evident that the piston head has been striking the ridge, hence the knocking.

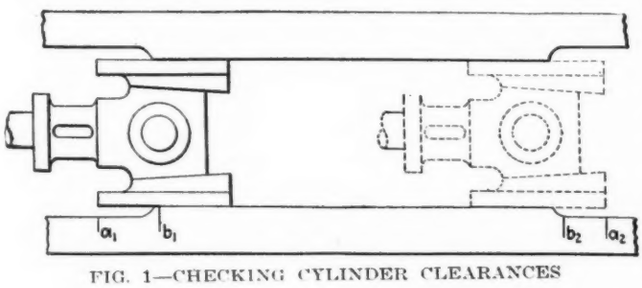


FIG. 1—CHECKING CYLINDER CLEARANCES

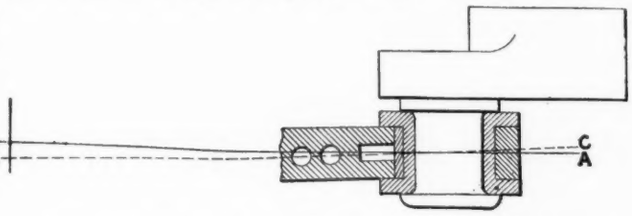


FIG. 2—EFFECT OF IMPROPERLY FITTED BRASSES

Our experience tells us that we must try out the clearances. The connecting rod may be at fault. Checking the piston clearances is only an elementary stage in machine construction and the method is familiar to most workmen, yet for the benefit of the younger engineers the writer proposes to describe the operation.

To try over the piston clearances, proceed as follows: Uncouple the large end of the connecting rod and push the piston up to one end of the cylinder until it butts against the cylinder cover. Then with a scriber make a mark a_1 across the guide in line with the front edge of the slipper, as shown in Fig. 1. Repeat the operation at the other end of the stroke and mark the guide in a similar manner a_2. Now couple up the connecting rod and move the engine round until you get the crank on the dead center, or until the crosshead is at the end of its travel, and make another mark b_1 in line with the mark on the guide across the guide. Move the engine around and repeat the operation on the other dead center, marking a line b_2 across the guide as before. We have now got the full travel of the piston and the clearances, a_1b_1 and a_2b_2 of the piston head from the cylinder cover at each end of the stroke. Take a pair of compasses and measure the distance from a_1b_1 and compare it with the distance from a_2b_2. In the event that the two distances are equal, we have nothing wrong with the clearances. If they are as shown in Fig. 1, the connecting rod is too short and must be lengthened by an amount equal to half the difference.

Turning our attention to the connecting rod, we alter the length by placing a piece of steel packing in front or back of the brasses according to the design of the rod.

In a case of this sort we assume that the connecting-rod brasses have been repaired or adjusted with the object of taking up the wear, without consideration being given to the resulting change in the length of the rod. The rod should have been kept to its original length as near as possible by inserting suitable packing behind the brasses.

It is plain that by adjusting the connecting-rod brasses without due consideration being given to the length of the rod, not only is the travel of the piston affected, but also that of the crosshead in the guides. If the guide has worn hollow, a ridge may have formed at the end, and the changing length of the connecting

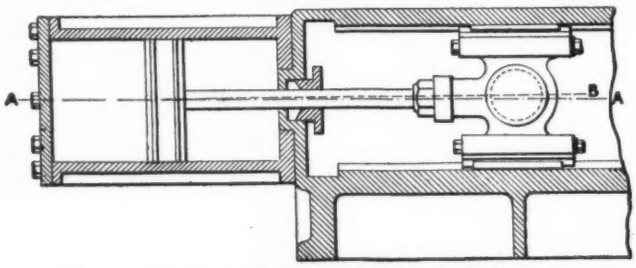


FIG. 3. RESULT OF MISADJUSTED CROSSHEAD

rod may cause the crosshead to strike the ridge, causing a knock.

Malalignment of the connecting rod may be caused by repairs and adjustments made to the brasses. An engine may have begun to heat at the crankpin journal, and on examination it may be found that the brasses and the crankpin are badly cut. The engineer may take a file and smooth down the cuts in the crankpin, using his caliper freely so as to keep the pin round, finally finishing it off with emery cloth and oil. He may then take a half-round file and file out the cuts in the brasses, and with a scraper bed them to the crankpin. The rod is then coupled up, and as far as appearances go a good job has been made of it. However, when the engine has been put to work, a heating of the brasses may again develop.

It is a wise plan, after executing repairs to the crankpin and brasses as described, to try the rod for alignment, because in truing up the crankpin journal and filing out the cuts from the bore of the brasses, misalignment may be set up.

It will be realized from Fig. 2 how small an amount of careless filing of the bore of the brasses will throw the connecting rod considerably out of alignment; thus a $\frac{1}{32}$ out of the true bore in a brass 3 in. long will throw a connecting rod 4 ft. long out by a $\frac{1}{4}$ in. at the crosshead end.

We will assume that by the filing out of the brasses the rod is out of line as shown in Fig. 2, where *AA* represents a true line through the center of the cylinder, guide and crankpin. The dotted line *CC* represents the line of the connecting rod which has been thrown over to one side of the crosshead. This indicates that the bores of the brasses are not at right angles to the center line of the connecting rod itself. To put this right the brasses must be eased and rebedded to the crankpin until the connecting-rod center line *CC* is thrown over coincident with the line *AA*. The small end of the connecting rod will then fall centrally into the jaws of the crosshead. Supposing that play exists in the crosshead path and that adjustments are made to the crosshead slippers for the purpose of taking up the wear without due consideration being given to the alignment. The piston rod is no longer horizontal and the piston, being thrown out of the true line as indicated in Fig. 3, may in time work up a ridge at the cylinder ends.

A simple method of procedure when adjusting the crosshead slippers, so as to take up the wear and at the same time to keep true the alignment, is as follows: Uncouple the small end of the connecting rod, withdraw the piston-rod gland and take out the packing from the stuffing box. If the neck ring and piston gland are a good fit on the piston rod, adjust the crosshead slippers until the piston-rod gland enters freely the stuffing box when tried with the crosshead at each end of the stroke.

Power Required to Pump Water

There are two general methods of figuring the power required to pump a given amount of water per minute against a stated head or pressure. The first of these is based on the weight of water discharged per minute and the head pumped against. If the water is merely drawn from one open tank and pumped into another open tank at a higher level through piping without appreciable friction, the head is the difference in level of the water in the two tanks. Where there is a pressure gage just beyond the pump discharge, the head in feet at that point is equal to the reading of the gage in pounds per square inch multiplied by 2.3. To this should be added the distance in feet from the center of this gage down to the level of the suction water. Where the suction water is at a higher level than the pressure gage, this difference in elevation is subtracted. The total head and weight of water discharged per minute being known, the horsepower is figured in the manner illustrated by the following example:

Suppose that 2,000 lb. of water per minute is being delivered against a total head of 50 ft. The net work done per minute is $2{,}000 \times 50 = 100{,}000$ foot-pounds.

Since one horsepower is equal to 33,000 ft.-lb. per min., the theoretical power required is equal to $100{,}000 \div 33{,}000 = 3.03$ hp. This is the power that would be required by a perfect pump. If the pump used has an efficiency of 60 per cent, the actual power required will be equal to $3.03 \div 0.60 = 5.05$ horsepower.

Another way to figure the work done in pumping water is to multiply the cubic feet of water delivered by the total pressure worked against in pounds per square foot. If the total head in feet has already been figured as previously described, it can be reduced to pounds per square foot pressure by multiplying by 62.4, the weight of a cubic foot of water. On the other hand, pressure in pounds per square inch may be changed to pounds per square foot by multiplying by 144, since there are 144 sq.in. in one square foot.

Suppose, for example, that a pump works with an inlet suction of 2 lb. per sq.in. and a discharge pressure of 70 lb. per sq.in., the inlet and discharge being on the same level. Then the total pressure worked against is 72 lb. per sq.in. or $72 \times 144 = 10{,}368$ lb. per sq.ft. If the discharge is 40 cu.ft. per min. the theoretical power will be $\frac{40 \times 10{,}368}{33{,}000} = 12.6$ hp.

EDITORIALS

The International Engineering Congress

THIS week in Rio de Janeiro there will convene an engineering congress under the auspices of the Brazilian Centennial Exposition. Although designated as an international congress, its scope and the representation will be largely confined to the Americas.

South America has long taken its engineering practice from France, where theory and mathematics have predominated. This was quite natural owing to French being read generally by the educated classes. Lately, however, it has become apparent to the South American that the physical characteristics and economic problems of the country are more susceptible to American engineering practice than to that of Continental Europe, where the conditions are entirely different. As a result the prestige of American practice has increased and the movement for learning English is growing.

There remains only to provide better means for bringing closer together the engineering thought of the two continents, for acquainting the people of South America with our standards and in turn acquiring a more intimate knowledge of their problems and requirements. It was with this thought in mind that the International Engineering Congress was conceived. Its delegates include representatives from our national engineering societies as well as the Engineering Institute of Canada, and the program is confined to the practical treatment of subjects of every-day importance rather than theory and academic discussion.

New York Creates a Coal Commission

GOVERNOR MILLER of New York obtained from the Legislature very broad powers in the matter of coal control. A commission is to be appointed to have complete supervision of the coal distribution in the state with the right to seize any and all coal found necessary, paying the owner a fair price from a revolving fund of ten million dollars. The governor, in his request to the Legislature, stressed the point that when the coal dealer asked only a fair profit he would be undisturbed, but at the first sign of profiteering the state would immediately step in and take charge of the situation.

State control of the distribution of coal is necessary. Its success, however, depends upon inducing the mine operators to ship coal into New York or any state attempting such control. Unless the United States Government acts promptly to place the coal supply in the hands of a commission, there is every reason to expect the coal operators to ship the bulk of this product to those states where prices are high and state control absent. In the case of the New York Commission the act passed by the Legislature grants the commission power to seize any coal passing through the state. This may serve to prevent operators and dealers from shipping coal through New York to other states where higher prices are ruling.

The necessity of interstate control is exemplified by the action of the Illinois operators, who, the daily press reports, inform St. Louis consumers that if the high price demanded is not paid, the coal will be shipped elsewhere. Without federal regulation state control will fail to meet the emergency. As a means of control, why should not a federal commission be established which would ship all coal to dealers on the consignment basis, thus absolutely fixing the resale price? Outside of anthracite for household use there will soon be coal enough for all, but if some sensible system of control is not established the blue sky may be the only limit to the prices paid.

The gouging indulged in by the coal operators will undoubtedly cause many plants to follow the Ford Motor Company, which will shut down September 16. If a concern the size of the Ford company is compelled to pay two to three dollars above normal prices for coal, what will be the situation of the average plant? Wages have not advanced, and if the operators attempt to rob the public, they will receive scant sympathy when next they encounter industrial disturbance.

Small Plants Should Be Simple To Operate

IT IS one thing to design and construct a power plant and an entirely different undertaking to get out of that plant what it was designed to accomplish. In the large central station, with an operating force organized to take care of every function of station operation, every refinement conducive to efficiency might be justified. On the other hand, in the small plant the more simple the equipment can be made and still give an intelligent understanding of its operation, the greater the possibility of the plant being maintained in an efficient condition. In fact, it might be said that a plant should be designed so that it will practically run itself after being started, it being the function of the operating crew to keep a record of operation and maintain the equipment in good condition.

In the small plant where the firing is done by automatic stokers, the coal weighed and delivered to the stoker hopper in a weighing larry and the draft regulated automatically, there is a far greater likelihood of the operating force carefully watching the boilers' operation and maintaining the best conditions, than in the plant where this work is done by hand. A fireman who has to undergo physical fatigue to shovel sufficient coal into the furnace to keep up steam cannot be expected to give serious attention to the plant's efficient operation. His chief interest naturally becomes centered in keeping up the pressure with the minimum exertion.

In making the boiler-room operations practically automatic, the same load can not only be carried with one-half to one-third the boiler capacity and the labor reduced to a minimum, but the operations have become

such that the attendant's functions are more mental than physical. This feature is probably deserving of more attention than is generally given it, since if a plant is going to be operated efficiently at all, it will be done when conditions are made favorable for so doing. If the plant attendants are to be expected to give careful study to operation, they must have time for such study without too seriously encroaching on the time necessary for their other duties. The nearer the plant's operation can be made automatic without undue complications, the more time the operators will have to study its performance.

The power plant of the Duratex Company, described in this issue, is a good example of making the operation of a small plant not only simple but to a large degree automatic. All the coal and ashes are handled by machinery, forced and induced draft are controlled automatically according to the steam demand, therefore the chief function of the boiler attendant is making adjustments to maintain a condition found to give best efficiency. The keeping of records in the boiler room has been made practically automatic by recording instruments, and these have been reduced to those necessary to an intelligent understanding of plant operation. The conditions under which this plant was constructed are undoubtedly more favorable than in the average plant for a simple design and keeping the amount of equipment at a minimum. However, the installation is worthy of careful consideration by designers and operators of small and medium-sized industrial power plants, in that it is a good example of how a load having widely varying characteristics is being efficiently handled.

Steam-Turbine Reliability

POWER-HOUSE operation in both public utilities and private plants demands reliability to a greater extent than efficiency. The cost of inefficient operation can usually be calculated in dollars and cents; lack of reliability involves loss of prestige often beyond calculation.

A turbine is sensitive in some degree to vibration, on account of the rotating member being in elastic suspension and the various turbine parts somewhat inclined to set up a vibration of their own. Requirements of alignment, balance, close clearances and changing condition due to expansion make accurate adjustment essential.

When properly adjusted, the inherent reliability may be realized and the adoption of the steam turbine for the most exacting service, such as supplying power for continuous manufacturing processes, railways, United States Navy, etc., indicates that this reliability is obtained in practice.

Large units are in a class apart from the great bulk of medium-sized machines, owing to the higher temperatures and pressures, rapidly changing designs, greater time required for repair and adjustment, and greater financial investment involved.

There is no apparent reason why the valve gear on such machines should give more trouble than in prime movers of other types. Main bearings do not require lost motion to be adjusted at frequent intervals as in a reciprocating machine, and with the ample allowance of bearing surface usually supplied, wear is not a cause of outage in commercial operation.

An ordinary case is recalled to mind where a seven-hundred-and-fifty-kilowatt mixed-pressure unit operated from June, 1915, to June, 1920, with no turbine renewals except soft packing on the valve stems. Repairs requiring one week were then necessary. The unit had been normally shut down once a week, although several months' continuous operation had been at times required.

A general inspection, together with a test of the emergency valve, should be made at least once a month, although many units are operated several months continuously. It is not reasonable to expect more than three hundred and forty working days per year, or ninety-five per cent of the time of any prime mover. The average size turbine has squarely met the requirements of commercial service.

Estimates show that there are approximately eight hundred units in privately owned plants in Massachusetts and Pennsylvania, averaging from five hundred to one thousand kilowatt capacity, so that the turbines covered in the recent N.E.L.A. prime mover report represent a comparatively small proportion of total units in operation in the country. It must also be realized that units of greater and less than the average availability are included.

The report of the Prime Mover's Committee of the N.E.L.A., covering seventy-eight turbine units from twenty thousand to forty-five thousand kilowatts in capacity, indicates that for various classes of service these units have been available from eighty-nine to eighty-two per cent of the time required. While this shows that the desired availability is certainly not realized, the record should not be taken as representing turbine performance in general.

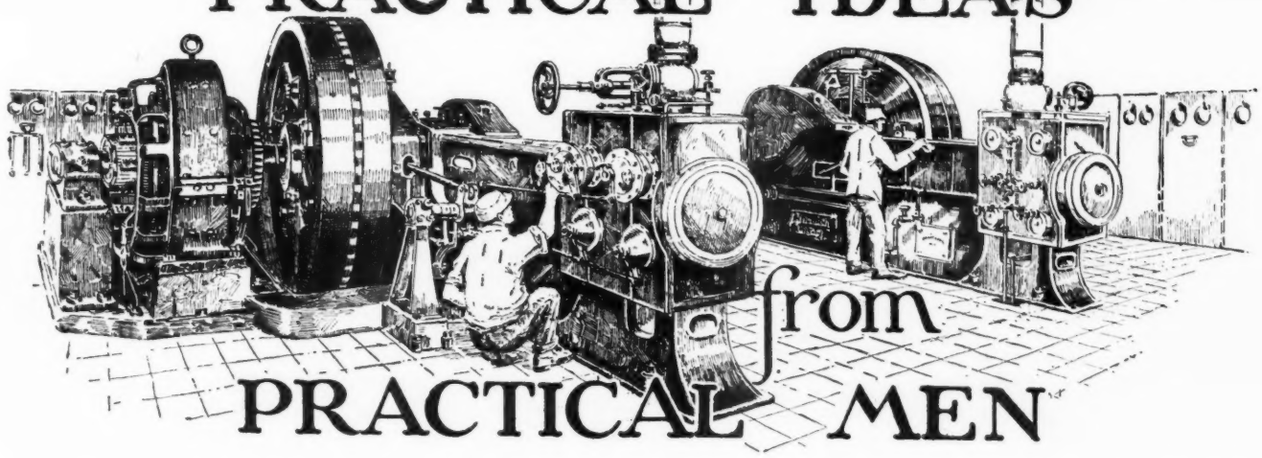
Use the Indicator

THE extensive employment of steam turbines in central stations and industrial plants has served to decrease the interest of many engineers in the indicator. This is a mistake, for the number of reciprocating machines in use is greater than ever before. To make up for the engines replaced by steam turbines and electric power, there are thousands of ammonia compressors in cold-storage and ice plants. These compressors, in fact, require more constant attention than a steam engine. In an ice plant the factors that influence the cost of operation are many times more than the factors that exist in a steam power plant. For this reason it is more difficult to detect the cause of any increase in power per unit output. The advantage obtained by the use of an instrument that will locate compressor wear, valve leaks, broken piston rings or improper lubrication, is at once evident. Engineers will find that the steam-engine indicator, properly arranged, will do all these things.

It is a well-known fact that the compression in an ammonia compressor will follow the adiabatic, or no heat-loss, curve if the machine is of good design and in proper working condition. One of the reasons engineers fail to indicate the compression has been the difficulty of constructing this adiabatic curve of comparison.

In this issue there is a discussion of the use of the indicator on ammonia compressors. Diagrams showing various misadjustments of the compressor are shown. The special insert showing a family of adiabatic and isothermal curves for ammonia compressors should be of assistance to all who are in charge of refrigerating plants. With the assistance of these charts an engineer is in a better position to study the compressor and, by correcting the defects revealed by the diagrams, to lower the cost of operation.

PRACTICAL IDEAS from PRACTICAL MEN



System in Taking Care of Stock

There are many power and industrial plants where no records are kept of stock received or when and where it is used in the plant, and often when a spare part is urgently needed, it is not available.

The usual condition is to have a stockroom where supplies as received are stored. I know of a number of plants in which the key to the stockroom hangs in the chief engineer's office, accessible to anyone. In my opinion this is a direct invitation to the men to take anything that they want for their personal use. Aside from the fact that fittings may be carried away, men will often take and use fittings without making any record of their work. To my mind it is absolutely essential, if a plant is to be run on a business basis, that some form or system be used whereby all stock ordered, on hand or used, can be traced at any time.

Some time ago I had occasion to visit a large paper mill to supervise the installation of a number of boiler instruments. As the nearest supply house to this plant

SUPPLY SLIP

DATE _____ JOB NO. _____

ARTICLES REQUIRED

_____

_____

_____

Where used.

_____

SIGNED BY RECEIVER, _____

SIGNED BY FOREMAN, _____

FIG. 1—SLIP USED WHEN DRAWING GOODS FROM STOCKROOM

was about 400 miles away, I wrote the master mechanic previous to going to the job, inquiring if the necessary material was on hand, and received a reply stating that he had checked up my list and had everything in the line of piping and fittings that we would need.

Upon arriving at the plant, we proceeded to collect the necessary piping and fittings. One item was 3,000 ft. of ½-in. brass pipe. By removing some old piping no longer in use we were able to secure 180 ft. of this size of pipe. We required 300 small elbows, and the best we could do was to find 18 elbows in the whole plant.

I then took the matter up with the master mechanic, and he was unable to give me even a good excuse for not having the material I needed; in fact, he did not seem

BOOK DATA.

JOB NO. A-1--Date, 2-4-22 Material, four 1/8" brass tees, two 3/8" brass tees. used to pipe CO_2 recorder overflow pipe. No. 3 recorder.

J. Smith & Helper

FIG. 2—RECORD OF JOB NUMBER, DATE, AMOUNT OF MATERIAL, AND WHERE USED

even interested in the matter. He showed me bills for all the material such as I needed. He admitted that it had been delivered to the plant, but did not know where it had been used.

As I had instructions to stay on the job until it was finished and had four men with me, I decided to take the matter up with the superintendent. This gentleman showed no interest in the work I was to do and stated that the work had been ordered by the board of directors and he assumed they knew what they were doing. He seemed to take the condition as something that could not be helped. He stated that a lot of men had the handling of the supplies of the plant and he could not understand how any system could be devised whereby a record of all these small parts could be kept.

After our work was completed, the paper company's consulting engineer came to look the job over, and I related to him the reason of our delay. He was much interested and ordered a system put in operation at once.

A young man was accordingly placed in charge of the storeroom, one key was issued to him and a duplicate key was locked in the office safe. All stock on hand was listed, and all new stock as it came in was listed and recorded. A list of parts of machines, fittings, etc., necessary to the upkeep of the plant was made out and these parts were secured, and as they were used they were replaced.

The arrangement laid out for the drawing of parts from the stores was as follows: The man desiring the part would secure from his foreman a slip (Fig. 1) on which the goods desired would be listed with a record of where and for what purpose they were to be used. This slip had to be signed by the man using the material and by the foreman. These slips were kept on file until a monthly check up was made and all supplies charged

STOCK CARD

PIPE FITTINGS

DATE TEES.

SIZE	NUMBER IN STOCK
1/8"	A-1 ~~1 1 1 1~~ 1 1 1 1 1 1 1 1 1 1 2-4-22
1/4"	A-2 ~~1 1 1 1 1~~ 1 1 1 1 2-4-22
3/8"	A-1 ~~1 1~~ 1 1 1 1 1 1 1 1 1 2-4-22
1/2"	1 1 1 1 1 1 1 1 1 1 1 1 1

FIG. 3—THIS CARD SHOWS NUMBER IN STOCK

against the stockroom accounted for. A book was kept in which the slip data were copied, each job being listed under a letter and number, A-1, A-2, B-1, B-2, etc. A copy of the data as taken from book is shown in Fig. 2. To this was added a card system for keeping record of what stock was on hand. This card, as shown in Fig. 3, covers the tees from ⅛ to ½ in. The numbers in stock are indicated by vertical lines which are marked across by a horizontal line as used. The job number and date are also indicated. The relation between the stock card and record made in the data book is clearly seen. A still further use for this card is the fact that it forms a ready means of determining just what supplies are on hand at all times. When new stock is received, the card is removed and the amount recorded, vertical lines being added in the proper place. The essential thing in a system of this kind is to fix the responsibility for the proper operation of the system to one man.

ARTHUR D. PALMER.

Fall River, Mass.

Idlers Versus Tighteners

Many names that have no real meaning are used by engineers and other practical people, and for that reason get applied to widely different things. On the other hand, some names are perfectly definite in the sense that they define, yet they are used wrongly by about five persons out of ten. There are local differences and individual comprehensions—and non-comprehensions. But when a word plainly describes the construction and use of an object, there should be no excuse for misapplying the word, and less for misapplying the article.

I go around a good deal, visiting all sorts of plants and meeting all sorts of people that own and run them. The other day I was in a friend's plant, and he and I got talking about belt tighteners. He believes in them, although the very name should have made him shy of their use. I take no stock in them. I would not have one about the place. Nor would I have an engine runner or a foreman who used one, any more than I would employ a boilermaker who used a drift to make the rivet holes "come fair."

Mind you, I'm talking about tighteners, not idlers. Idlers are "bay horses of another color." An idler has an apparently inefficient name, but is just as efficient as the tightener (with which it is often confused) is inefficient. An idler, then, to be precise, is a loose pulley that practically puts no stress on the belt or on the journals and bearings, and has no other use than to take up any unnecessary slack in the loose fold of the belt and wrap the latter farther around the small pulley. I say "the small pulley," because, other things being equal (as, for instance, the material of the pulley rim), the small one is the one that has the most need of help, especially where there is great difference in the pulley diameters or the shafts are very near together. The tightener, on the other hand, may merely have the effect of increasing the tightness of both folds; and in this case, as it is always the difference between the stresses on the two folds that gives driving power, the tightener may really give no increased belt pull except on the journals.

Please get this straight. The driving power of any pulley is measured by the linear speed times the difference in pull between the tight and the slack fold. So if we put considerable strain on the belt, we tend to draw the two journals together, and the difference between the stresses on the two folds may be much less than where one belt-fold wraps well around and hugs well, and the other fold merely follows it, as it were.

Well, my friend was everlastingly sure that the tightener was the cure-all for the ills (and they are many) that belts are heir to, that he wanted to bet me a Stetson hat that there was no increase of friction, at least to speak of, by its use. I could not take him up, for the simple reason that I would have been betting on a certainty. I have tried the thing out too many times to be in doubt of the outcome. But I agreed to a tryout and to buy him a hat if I did not prove that I was entirely in the right. The only condition I made was that if I proved my point he should show his appreciation of that fact by banning tighteners forever after.

We tried the experiment by rigging up a brake on a shaft so we could load the latter up to the point of slipping of the belt, and measure the power by an indicator on the engine. The belt was rigged with both a tightener and an idler, either of which could be thrown in or out, at will. Then we took cards with the idler alone, and the tightener alone, and both on.

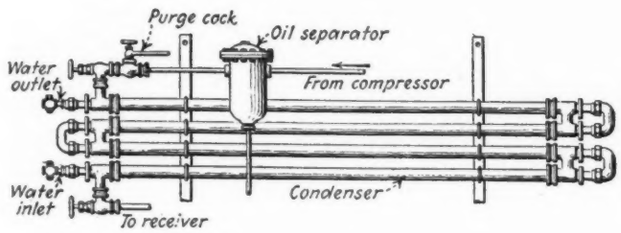
The result convinced my friend and the others who assisted in the test, that the tightener increased the friction about 20 per cent for any given net drive, and that with the idler alone the belt would transmit a higher power than with the tightener and the idler together. As to this last I had said nothing; but once that was proved, the reason had to be given; and it was up to me, in the light of previous tests, to give it. Up to a given tension, the driving power of a belt is increased provided the tension is not increased on both folds; but that maximum being passed, the drive gets less, because the belt is smoothed by the combined pressure and slip (there is always slip, else the belt would not drive at all) and loses a part of its grip on the pulleys. This fact is not generally known and will not be generally believed.

But it accounts for another fact—also not generally known and still less generally believed—that a new belt drives better with the flesh side next the pulley, and afterward drives best with the grain side next.

New York City. ROBERT GRIMSHAW.

Where Should the Purge Cock be Located?

I am in charge of a small refrigerating plant with a cooler in the basement. Recently some evaporating coils were added to one of the banks, and of course this bank of coils was pumped to about 28 in. vacuum. As



PURGE COCK IS ON HOT-GAS LINE

soon as this stand was cut out, the other was put back into service. But when the repairmen finished, they purged out only once with the machine running, so we had to purge out again.

A few days ago we had one of the cylinders open to repair a suction valve in the piston. This time the condenser was not purged, as everything was cut off from the cylinder, both high and low sides. Mr. Gunn, in his article in the July 25 issue, says the purge cock should be located where the temperature of the gases and vapors is lowest. The illustration shows where ours is—on the high-pressure hot-gas line—and when we purge the condenser, which is a single stand, we have to change our pail of water three or four times. Can some reader tell me if the purge cock is connected at the proper point? R. G. SUMMERS.

Rochester, N. Y.

Condenser-Type Voltage Detector

Since there is ordinarily no difference in appearance between live and dead conductors, it is essential to provide some reliable means for testing for potential before a presumably dead conductor is grounded or touched.

While various devices are used to determine whether conductors are alive or dead, the condenser type of potential detector is used by several power companies, with good results, when applied to circuits the voltage of which exceeds 2,200. Among the features favoring the use of this type of detector are sturdiness, reliability and ease of handling.

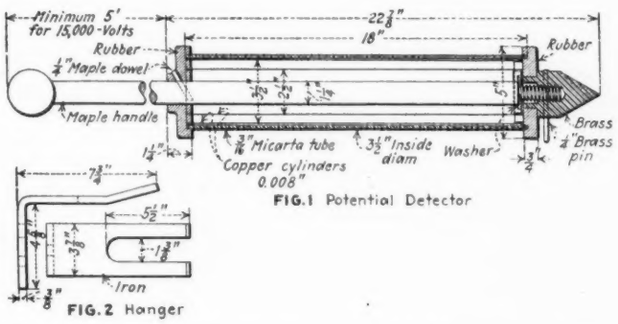
Fig. 1 indicates how a potential indicator may be constructed. The condenser consists of two sections of 0.008-in. sheet copper forming concentric cylinders of 3½ in. and 2½ in. diameter, and having a length of 17¾ in. The 3½-in. copper cylinder is inclosed within a Micarta tube, and the condenser is assembled on a maple rod 1¼ in. in diameter. This rod should be well seasoned and impregnated with oil or some other insulating material to prevent the entrance of moisture. An ordinary switch stick, with the metal end removed, is suitable for mounting the condenser on for use about the plant.

Assuming that the detector is to be used on a 15,000-volt circuit, the distance from the end of the handle to the hard-rubber flange doweled to the rod should be at least five feet. This flange acts as a support for one end of the Micarta tube and for the open ends of the copper cylinders. The other end of the Micarta tube and the closed ends of the copper cylinders are clamped against another rubber flange, which is clamped against a brass washer by the brass tip. This tip is screwed on the maple rod and is electrically connected to the end of each copper cylinder. The tip is doweled to the rod by a long ¼-in. brass pin.

The completed detector should be supported in a dry location by the hanger shown in Fig. 2, which is arranged for wall mounting and may be constructed of ⅜x2⅞-in. flat iron.

A conductor is tested for potential with this device by touching it with the brass tip or side pin, then withdrawing the detector a short distance. If the conductor is alive, or energized, a static discharge will, on an 11,000-volt 60-cycle circuit jump a 0.4-in. gap between the detector tip and the conductor. Usually, in dim light or darkness the static discharge may be seen, but if invisible, the sound of the discharge gives an audible indication of potential on a 11-kv. circuit. On a 2,200-volt 60-cycle circuit the discharge and accompanying sound is not loud, but may be detected. As the voltage of the circuit is increased, the sound of the discharge becomes increasingly louder, but as this detector is insulated for use on a 15-kv. circuit, it should not be used on any circuit where the voltage exceeds this value.

While the condenser type of detector is a reliable device, it should, as a safety measure, be tested by being brought in contact with a conductor that is



FIGS. 1 AND 2—CONDENSER TYPE POTENTIAL DETECTOR AND HANGER

known to be alive, noting the indication just before and immediately after being used.

Owing to the importance of determining if conductors are dead before grounding or working on or near them, it is thought that some reliable form of potential detector should be used in every well-operated station; and where the voltage is sufficiently high, the condenser type of potential detector will be found suitable for testing purposes. Besides being well suited for station use, the detector described in the foregoing should prove useful to linemen and others who have occasion to test for potential. RALPH BROWN,

Belden, Calif. Great Western Power Co.

Water-Column Connections

The arrangement of water-column connections and drains described by Mr. Cultra in the Aug. 15 issue has some advantages, but it appears that he is familiar only with good feed water because he eliminates the installation of the usual crosses to obtain "a much neater job of piping."

It has been my experience that water-column connections tend to clog up with accumulations of scale at the point where they enter the boiler. Mr. Cultra has provided for no method whatever of cleaning this portion of the water connection. The use of tees or crosses on the steam connection appears to be superfluous because steam connections do not collect impurities as water connections do.

Mr. Cultra's statement, that "crosses and plugs are often used in place of elbows and tees for the purpose of clearing the pipes, but on high-pressure boilers I consider it much better to disconnect the pipe than to risk breaking the cross or connections when attempting to remove the plugs," would indicate that he does not make a practice of cleaning his water-column connections at frequent intervals, because if brass plugs are used, they can be removed with little effort if they are properly lubricated when put in place and removed several times a year. The practice of permitting water-column connections to stand for long periods without being opened is recognized to be dangerous, and many boiler inspectors insist that these connections be broken for examination at every internal inspection.

Newark, N. J. J. WELDON MELROY.

An Examination Question

The examination question submitted by H. P. in the August 15 issue may have been based on the improbable assumption that steam is admitted to the steam cylinder during the full stroke and the erronous assumption that the pressure in the compressor cylinder could be constant during the full stroke. The conditions would be logical if the question referred to a pump, and it must have been something of the sort that the examiners had in mind. In that case a piston having 75 per cent of the area of the steam piston would exert a pressure of 100 lb. per sq.in. if the machine were 100 per cent efficient. As the machine is only 80 per cent efficient, the 75 per cent area must be reduced by 20 per cent or a final area 60 per cent of the area of the steam piston will be required to exert a mean effective pressure of 100 lb. per sq.in. in the compression cylinder.

The question would not demonstrate a very profound knowledge of air compressors if it was intended to be answered in this way, but it is right in line with the usual inconsistencies of license examinations. It has always brought a smile to remember the care with which a ball-and-lever safety-valve problem was worked out for a marine examiner twenty years after that type of valve had become obsolete in marine service. Another interesting question usually asked was what to do if the coupling bolts in one of the couplings of the propeller shaft sheared off. The answer that is accepted is that one bolt should be taken from each of the other couplings to replace the broken bolts. A more interesting question would be, "How much would be left of a coupling four inches thick if it had just sheared off six two-inch bolts?" PAUL F. CHRISTOPHER.

Dedham, Mass.

Painting Radiators

I read with interest in the Aug. 22 issue the article on "Painting Radiators." However, I cannot agree on what has been said regarding the relative efficiencies of the two kinds of radiator paints, enamel and bronze.

About a year ago, I noticed a table on page 1344, in the "Mechanical Engineers' Handbook," published by Lionel S. Marks, dealing with the relative values of radiator paints. The figures given in this table surprised me, and as an opportunity soon presented itself to check these figures, I did so and found them to agree very closely with the results of my tests.

Using bare pipe as a comparison, a pipe painted with either gold or aluminum bronze at the usual radiator temperatures—that is, of about 2 to 3 lb. gage and a room temperature of 70 deg.—the efficiency of the radiating surface will be decreased from 20 to 25 per cent, and if on top of the bronze a coat of white enamel is applied the efficiency will be brought back nearly to the original efficiency of the bare pipe, or from 95 to 98 per cent. To make my meaning clear, a four-column radiator painted with aluminum bronze will radiate no more heat than a three-column radiator painted white. At higher temperatures this difference in efficiencies becomes more marked, which would be expected when the physical laws governing this subject are studied.

All radiating surfaces dissipate heat due to conduction, convection and radiation. The dissipation due to conduction and convection varies nearly in proportion to temperature difference, while heat lost by radiation varies as the fourth power of the absolute temperature. This means that if the absolute temperature is doubled, the heat radiated is increased 16 to 1. Also it is an established fact that mirror-like surfaces are poor radiators of heat.

Since bronzes consist of multitudes of small metal particles, a surface painted with bronze will really consist of a number of small mirrors.

This all means that at low temperatures the portion of total heat dissipated by radiation is small, so that the differences in efficiencies of the two paints are less than at the higher temperatures, because while the radiant energy given off by the enamel increases very rapidly, the mirror-like surfaces of the bronze hold this component of the total heat down on higher temperatures and consequently cause a greater difference in heat dissipation of two classes of paint to show up.

In view of the fact that few engineers realize the marked difference in the efficiency of radiators painted with these two classes of paint, the results of the experiments I have made might be of interest.

Montclair, N. J. R. S. LANE.

Condensing Equipment at Gennevilliers

I have read with a great deal of interest the article regarding the Gennevilliers Station in the August 1 issue of *Power*, particularly the data in connection with the condensing equipment. As I understand it, the article sets forth the guarantees made on the various pieces of apparatus. It is interesting to follow the matter through to determine whether the actual condenser performance guaranteed can be maintained after the condenser has been in operation an appreciable length of time.

Referring to page 162, a comparison is made between the Paris Station, Colfax, and the Philadelphia Electric Co. as to the square feet of condensing surface per kilowatt, and the author, Mr. Andrews, has set forth various suppositions as to why a smaller amount of surface was used in the Paris station. In the first place he compares the amount of circulating water supplied to the condenser with the capacity of the condensate pump. It would be impossible to draw any conclusion from this, as the two stations do not have the same relative excess condensate pump capacity. Furthermore, it would be impractical to make any comparison as to the amount of surface and cooling water unless charts were given indicating the minimum and maximum water temperatures and the yearly average water temperature for the various stations.

The author calls attention to the fact that it is common practice in this country to use 1-in. tubes, whereas in the Paris station the tubes are approximately ⅞ in. in diameter. While we concur with Mr. Andrews that slightly better heat transfer can be expected with a smaller tube, the difference would hardly make any appreciable difference in the amount of surface required. One-inch tubes are considered good practice in this country on account of the existing water conditions, as there is materially less danger of fouling of tubes.

The amount of condensing surface used for each turbine is specified as 37,650 sq.ft., the condenser being served by two circulating pumps each having a capacity of 30,000 gal. per min., and the article states that one pump is considered a spare. In other words, the article would lead one to believe that only one circulating pump is used, regardless of water temperature or amount of load carried. The condenser tube length is not specified, but we have assumed this as being 20 ft., and when circulating 30,000 gal. per min., the water velocity would amount to 2.39 ft. per sec. In order to maintain 29 in. of vacuum (referred to a 30-in. barometer) with 55 deg. F. circulating water, a heat transference of 457 B.t.u. per sq.ft. per degree per hour would be required when carrying a load of 30,000 kw. If we assume the load as being 40,000 kw. circulating 30,000 gal. per min. and maintaining 29 in. of vacuum it would require a heat transfer of 780 B.t.u. per sq.ft. per degree per hour with a very low water velocity; namely, 2.39 ft. per second.

If we assume that 60,000 gal. of water were circulated, it would mean maintaining a heat transfer of 355 B.t.u. for 30,000 kw. and 523 B.t.u. for 40,000 kw., both of which are based on a water velocity of 4.78 ft. per second.

Assuming a circulating-water inlet temperature of 55 deg., it would be impossible to maintain 29 in. of vacuum when carrying 40,000 kw. and circulating 30,000 gal. per min., as this would represent 23.8 deg. rise, which would give a discharge-water temperature of 78.8 deg. or within 0.2 deg. of the temperature corresponding to the vacuum maintained.

The ratio of condensing surface per kilowatt is much greater in this country than in either England or France, and the larger ratio is born of experience. You need not go back many years or travel out of the City of New York to find numerous installations where the square feet of condensing surface is very small, but in all these stations the demand for power has been so great that the operators cannot commercially afford to take the units out of service for frequent cleaning, as would be necessary with a small ratio of surface to kilowatts. All of this is due to the severe water conditions encountered in the majority of large stations in this country.

Therefore the answer to the relative amount of surface used in the different stations depends entirely upon the heat transfer assumed, and the experience obtained in this country indicates that high vacuum must be based on the use of a conservative value for heat transfer rather than a high heat transfer that can be obtained only under ideal water conditions and with frequent and thorough cleaning of the condenser.

There is one other point that is not quite clear in this article. It refers to the air ejectors. The author has stated that each condenser is served by three air ejectors, one of which is a spare. The air ejectors are designed for 225 lb. steam pressure, and it is stated that inasmuch as there is a pressure of 313 lb. gage available, there is approximately 100 per cent overload capacity in the ejector. This is incorrect, owing to the fact that if the ejectors are designed for 225 lb. pressure, they must be operated at this point, and if higher pressures are used at the nozzle, the ejector capacity will not be increased, but on the other hand, it will be decreased on account of the excess amount of steam passing through the nozzle, which decreases its air-handling capacity.

It is further stated that only part of the ejector steam is recovered, this being necessary in order to avoid carrying excessive amounts of air into the condensate tank. It is quite possible to design equipment that will remove the majority of the air, and while we agree that the air cannot be entirely eliminated, it does not seem like the best efficiency to generate steam for the air-removal apparatus and then permit it to escape. We are wondering why a more efficient type of air-pump was not employed.

South Philadelphia, Pa. D. W. R. MORGAN.

QUESTIONS AND ANSWERS

Flow of Steam Must Be Accompanied by Drop of the Pressure

Is the pressure in the steam chest or cylinder of an engine the same as the pressure in the boiler? J. S.

The only condition under which the pressure in the steam chest or cylinder can be as high as the boiler pressure is when no flow of steam is taking place and there is no loss of heat accompanied by condensation, although the drop of pressure from that cause may be too small to be detected with a sensitive pressure gage.

The flow of steam, through a pipe or throttle valve from the boiler, cannot take place without a drop in the pressure at the point of discharge, and therefore when any quantity of steam is taken by the engine, the pressure in the steam chest must be lower than the boiler pressure and, in the same manner, the pressure in the cylinder must be larger than the pressure in the steam chest.

Allowance For Moisture in Steam

What effect on engine economy has moisture contained in the steam? J. F. G.

Carefully conducted experiments have been made for determination of the effect of water in steam on the economy of a plain slide-valve engine where the moisture was introduced by condensation, causing the quality of the steam to range from 99 per cent to 58 per cent dry. Such experiments have shown that throughout the range of qualities of steam used, the consumption of dry steam per indicated horsepower-hour remains practically constant, indicating that the water was an inert quantity, doing neither good nor harm except for its presence in a purely mechanical sense. This is the usual commercial assumption with reference to the steam consumption of reciprocating engines. That is to say, if an engine is supplied with steam containing 5 per cent moisture, the equivalent dry steam consumption, or "water rate" of the engine, is assumed to be 95 per cent of the quantity actually supplied.

Placing Lubricator in Main Steam Line

Can a lubricator be placed in a main steam line ahead of all machinery and be as efficient as a lubricator on each machine? A. C. B.

Aside from trouble caused by leakage at joints in the main line and branches induced by presence of oil, a single lubricator cannot be as efficient unless the improbable condition is assumed that the lubricating oil is perfectly atomized and equally diffused throughout the whole body of steam; and also that the requirement of oil for all machines, as used, bears a constant ratio to their respective steam consumptions. These conditions rarely, if ever, would be present, and satisfying the requirements of the machines needing the most oil in proportion to steam used would result in waste of oil on the others.

Relative Steam Economy at Different Elevations

A condensing-steam power plant at sea level is a duplicate of one installed on a mountain. Both plants are operated with steam at 150 lb. boiler pressure and carry the same load. The vacuum at the sea-level plant is 28½ in., while that obtained at the mountain plant is 27½ in. In each instance the vacuum is within one inch of the height of barometer of the place. Which plant should operate with better steam economy? W. L. T.

The absolute pressure in a condenser, expressed in inches of mercury, is the difference between the barometer of the place and the number of inches of vacuum. Hence with the same difference of 1 in., the absolute back pressure in the condensers would be 1 in. of mercury column pressure in each instance. However, as the absolute initial pressure of the steam is gage pressure plus the pressure of the atmosphere at the place, the plant at sea level is operated from a slightly higher absolute pressure. But the greater amount of work available would be less than $\frac{1}{10}$ of 1 per cent and therefore, to all practical purposes, the steam economy of the plants should be the same.

Best Submergence for Air Lift

We have an air lift in a well that is 180 ft. deep and cased with 6-in. pipe. In summer time the water in the well stands 45 ft. below the surface of the ground, and during the winter months the water stands about 10 ft. higher. The air pipe 1½ in. in diameter, extends 140 ft. below the surface of the ground. Is this the right length for the air pipe for best results? C. A. G.

No set of rules can be given for determining what is proper submergence for the air pipe, and no formulas can be devised that will be more than an approximate guide. This is due to the variations of combinations of the conditions, especially uncertainty of the amount of drop of the ground water level outside of the discharge pipe during operation of the air lift.

The best depth below the ground surface for injection of compressed air is a matter for determination by experiment in each case, and for economical operation an air lift should not be installed without such experimenting. Under average conditions the best results usually are obtained when the submergence (that is, distance from free water surface outside of the dis-

charge pipe, during operation of the air lift, down to the depth at which the air is liberated in the water pipe) is two to three times the actual lift from the free water surface outside to the point of discharge.

Assuming the point of discharge to be two feet above the surface, and the drop of the ground water level to be three feet during operation of the air lift, then for a standing water level of 45 ft. below the surface of the ground when the air lift is not in operation, the actual lift would be 2 + 45 + 3 = 50 ft., for which the submergence should be at least 100 ft. below the working level outside of the water pipe, or total depth below the ground surface of 3 ft. drop + 100 ft. submergence = 103 ft. Under the conditions it probably would pay to extend the air pipe at least 8 ft. deeper below the ground surface.

This same length of air pipe probably would be found equally as efficient as the present length for use during the winter season, when the ground water stands 10 ft. higher than during the summer months; for without any drop of ground water during operation of the air lift, and assuming as before that the point of discharge is 2 ft. above the surface of the ground, the actual water lift would be 35 + 2 = 37 ft. and the air pipe submergence would be 95 + 10 = 105 ft., or less than three times the actual water lift.

Relative M.E.P. for Higher Discharge Pressure

Will increasing the discharge pressure of an air compressor always cause an increase of the mean effective pressure? C. M. A.

With no cylinder clearance there always would be an increase of the mean effective pressure. For example, as illustrated in Fig. 1, compression from atmospheric pressure without clearance and with the discharge pressure *D*, would give a diagram *ABCD*. By increasing the discharge pressure to *E* the diagram *ABFE* would be

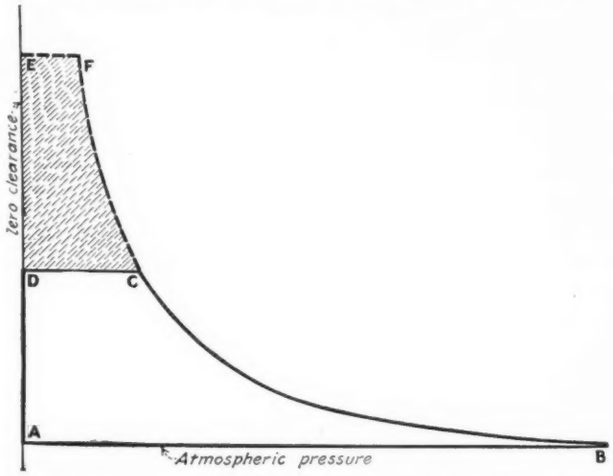


FIG. 1—COMPRESSING AIR TO A HIGHER DISCHARGE PRESSURE WHEN CYLINDER CLEARANCE IS ZERO

obtained, larger than *ABCD* by the shaded area *DCFE* and the m.e.p. would be greater.

However, more or less clearance is necessary for practical operation of a compressor, as the piston cannot make actual contact with the heads of the cylinder, and with ordinary designs there are clearance spaces in the air passages which connect the cylinder with the suction and discharge valves. Whatever air remains in the clearance space at the beginning of the suction stroke has been compressed to the discharge pressure and re-expands to the suction pressure, thereby reducing the m.e.p. The form of indicator diagrams due to clearance is illustrated in Fig. 2. In the diagram *GHJK* with the discharge pressure *H*, the re-expansion of air remaining in the clearance space in the beginning of the suction stroke is shown by the curve *JK*. If compression had been continued to a higher pressure *L*, then re-expansion of the same volume of clearance air

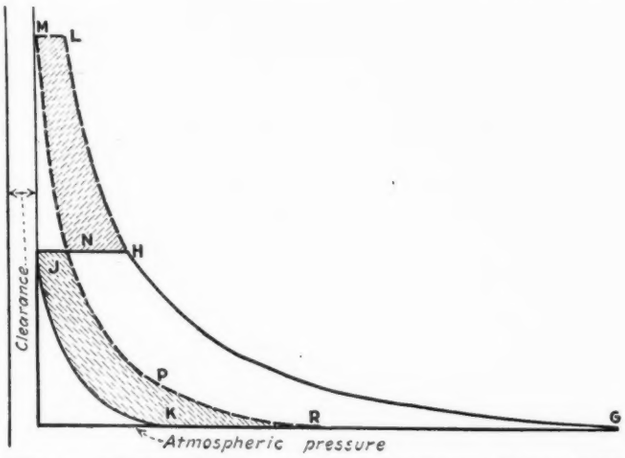


FIG. 2—COMPRESSING AIR TO A HIGHER DISCHARGE PRESSURE WHEN THERE IS CYLINDER CLEARANCE

from a higher pressure would carry the re-expansion line *MNPR* considerably to the right of *JK*, and for a given clearance the relative discharge pressure may be such that the area *HLMN* becomes less than the area *NPRKJ*, and in that case the total area and m.e.p. of the higher-pressure diagram *GHLMNPR* becomes less than the area and m.e.p. of the diagram *GHJKRG*.

Although the m.e.p. may be less for compression to the higher discharge pressure, it is to be borne in mind that less free air is taken in, compressed and actually discharged per stroke, for in such a case the beginning of intake must be delayed until the clearance air has re-expanded down to the intake pressure. On the lower pressure diagram *KG* represents the volume of free air taken into the cylinder to be compressed to the pressure *H*, and on the higher-pressure diagram the volume of intake air is represented by the less distance *RG*.

Chattering of Safety Valve

What causes hammering or chattering of a spring loaded safety valve on a boiler? R. H. C.

The chattering may be due to having too long or too small a connection for the safety valve as, under those conditions, when the boiler pressure rises to the pressure at which the valve blows off, there would be rapid alternations of higher and lower pressure under the valve to synchronize with vibrations of the weighing spring. With most forms of spring-loaded safety valves, chattering or hammering of the valve on its seat can be stopped by increasing the amount of "blowdown" of the valve.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Factors in the Spontaneous Combustion of Coal*

By O. P. HOOD

ALTHOUGH we frequently hear of spontaneous combustion, it actually occurs in only a small percentage of the cases in which coal is stored. There is practically no chance of spontaneous combustion in small piles or with anthracite. The main interest in the subject lies in the large piles needed as reserves for public-service utilities and the industries. The subject is a complicated one, involving many factors in chemistry, physics and engineering, so that there is need of pointing out what are the

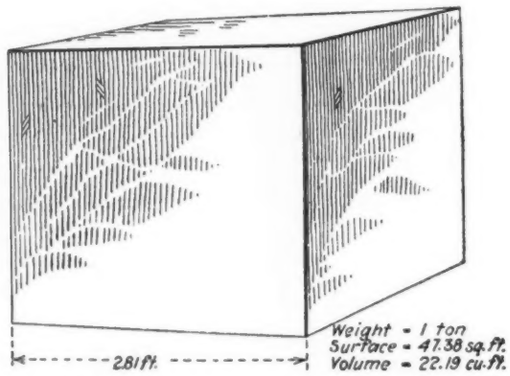


FIG. 1—ONE TON OF COAL IN A SOLID CUBICAL BLOCK
If this were crushed to pass through a 16-mesh screen, the area would increase from 47 sq.ft. to about one acre.

factors most concerned in the spontaneous heating of coal. It is necessary to know what to look for in order to draw reasonably accurate conclusions as to the cause of any given case of spontaneous combustion.

In the first case, the phenomenon is concerned only with the actual surface of the coal (not the surface of the pile). It is a well-known fact that large pieces of any substance have a smaller surface area per cubic foot or per ton of weight than small pieces. Fig. 1 shows the size, weight and volume of a ton of coal when molded into a single solid cube. The block has only about 47 sq.ft. of area, but if this cube were crushed until all of it would pass through a 16-mesh screen, the area would be increased to about an acre. Since the area per ton increases so rapidly as the particles of coal grow finer, it is evident that the source of spontaneous combustion, which (as already stated) is a surface phenomenon, must be looked for in the fine coal. If fine coal is kept out of the pile, the heating surface is relatively so small as to remove the danger of spontaneous combustion.

If oxygen is in contact with the coal, the amount of heat generated depends on the surface and also on the temperature. Much more heat is generated at 80 deg. than at 60 deg. Starting at 20 deg., it seems to be approximately true that for every 10 deg. rise in temperature the amount of heat generated is about doubled. The general trend is shown in Fig. 2. It is a matter of observation that coal stored during the hot months of summer, and in heated regions, is much more liable to spontaneous combustion than coal stored in colder climates and in cooler seasons.

The action is most rapid when the coal is freshly broken. At that time the rate seems to depend largely on the amount of oxygen in the coal. However, that cannot always be depended upon, although the high-oxygen coals of the Middle West and the sub-bituminous coals and lignites of West show increasingly active rates of heating. After a time the coal surface apparently becomes satisfied. This should be kept in mind when considering the wisdom of crushing coal immediately before storing it. Spontaneous fires rarely occur after the coal surfaces have been exposed for three months.

*Abstract of Technical Paper No. 311, U. S. Bureau of Mines. A short outline of this paper was given in the August 1 issue of *Power*.

As the rate of heating increases with the temperature, it is evident that if the heat generated is not removed, the process becomes self-aggravating, and the rate of heat generation, instead of falling with time, may rise. In such circumstances each bit of heat given off serves to increase the temperature which, in turn, increases the rate at which heat is given off. If the temperature of the pile reaches 140 or 150 deg. F. and continues to rise, there is a high probability that within a few days or a few weeks a destructive temperature will be reached. If the temperature reaches 160 to 180 deg. F., it is almost certain that a destructive temperature will be reached and that the coal must be moved. Immediately the question of getting rid of the heat is presented.

Air moves rather freely through a pile of coal, even where there is no wind. To illustrate this point, one may cite a partial cargo of coal that was loaded into a bottom at New York and carried under sail to Norfolk. The general temperature of the pile at loading was known. On arrival at Norfolk the temperature of the coal had so increased as to make the adding of further cargo dangerous. From the known rise in temperature of the coal, it was possible to figure roughly the exchange of air that must have been made within the partial cargo in order to supply the amount of oxygen represented by the heating effect. The general order of magnitude was that all the air in the spaces between the pieces of coal must have been changed 20 to 30 times during the period of heating. This coal was, of course, protected from winds, so the illustration shows how great may be the natural ventilation produced within a coal pile by differences in temperature and by the daily variations of barometric pressure. In many piles of coal this natural change of air, or breathing, is enough to carry away the heat generated.

Fig. 3 is a diagram indicating how coal tends to segregate when dropped onto a pile from a single point. It will be noted that the finest coal stays at the top and center, while the larger pieces move to the lower outer edges of the pile.

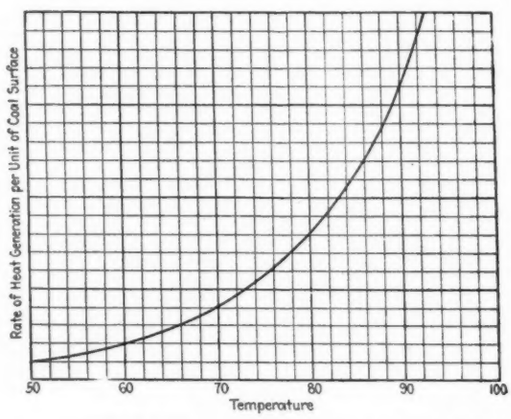


FIG. 2—GENERATION OF HEAT IN COAL PILE AT INCREASING TEMPERATURES.

It is evident that fires will not start in the outer edges, because the blocks are large and there is good ventilation. On the other hand, the fine coal in the lower center is so densely packed that there is not enough oxygen to cause much heat. Somewhere between the two extremes of the central core of fine coal and the large pieces on the edge, may be areas where the ventilating current is just sufficient to supply oxygen for a maximum rise in temperature and yet insufficient to remove the heat as generated.

Some observers have stated that fires in large coal piles are generally found in the region from 5 to 8 ft. below the surface on the flanks of the pile. It is evident that we are here dealing with a very complicated ventilating problem.

For example, a slight increase in ventilation at the center of the pile would evidently increase its liability to spontaneous combustion, whereas the same applied to the outer edges would decrease it. There are many other factors of minor importance. One of the troubles has been that undue attention has often been given to the minor factors, such as the sulphur or the volatile-matter content of the coal,

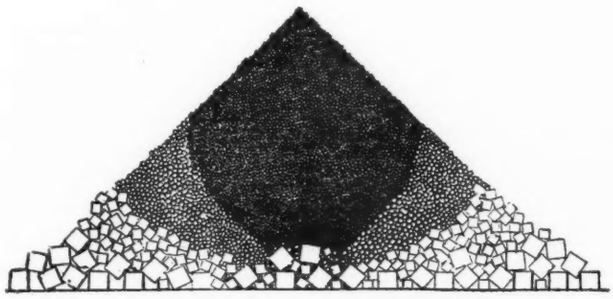


FIG. 3—SEGREGATION OF DIFFERENT SIZES OF COAL IN A CONICAL PILE

height of pile, etc., while the main factors, such as initial temperature, breakage in handling, freshness of the coal and the screening before storage, have been overlooked or minimized.

Controversy Over Federal Dam Still Unsettled

The efforts of the City of Minneapolis to obtain the use of the federal high dam in the Mississippi between Minneapolis and St. Paul have developed into a complicated controversy involving the question of efficiency of municipal operation as well as the engineering problem of the value of the dam as a source of municipal power. The use of the dam is also sought by the City of St. Paul and the Northern States Power Co., and the whole matter is now before the Federal Power Commission.

While the federal government was constructing the dam the Minnesota State Legislature passed an act creating the Municipal Electric Co., to consist of the cities of Minneapolis and St. Paul and the University of Minnesota, for the sole purpose of utilizing the dam. This was in 1911, and the dam was finished in 1914. In due time the Municipal Electric Co. was incorporated and legally ready for business. But the act creating it had not given it the power to issue bonds so that it could construct the necessary power plant and distributing system. As a result the whole matter was thrown back to the legislature. Because, however, of discouraging engineering data presented to it, the legislature has thus far refused to clothe the Municipal Electric Co. with the indispensable bond-issuing authority.

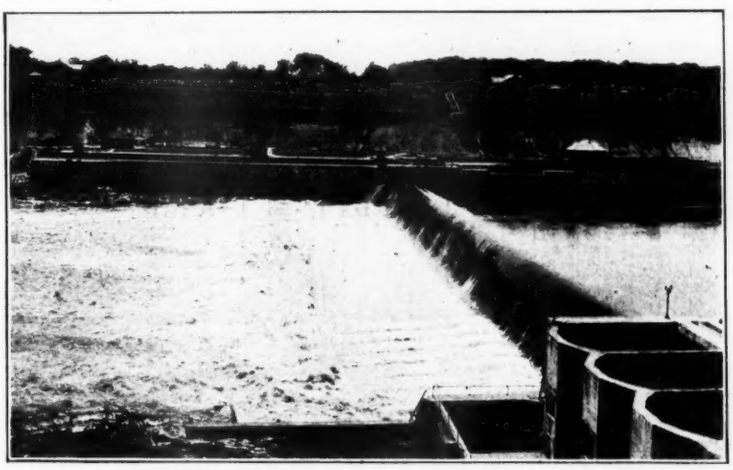
Owing to the impotency of the Municipal Electric Co., the City of St. Paul and the Northern States Power Co. several month ago independently applied to the Federal Power Commission for the right to use the dam. Mayor Leach of Minneapolis thereupon intervened on behalf of the Municipal Electric Co., insisting that that company could operate the dam efficiently for the municipal purposes contemplated by the legislature in 1911. These purposes included the lighting of the city streets and the plumbing of the city water. To combat the efforts of Mayor Leach the Greater St. Paul Committee was organized, consisting of prominent St. Paul business men and city officials. This committee proceeded immediately to have a thorough engineering investigation made of the dam.

The data resulting from the investigation confirmed the objections of St. Paul to the functioning of the Municipal Electric Co. It was found that the dam could produce only 10,000 hp., although it would cost $3,000,000 to construct the power plant and distributing system necessary for lighting the city streets—this cost besides a rental payable to the federal government of $150,000 per year, or a total capital cost of about $4,000,000. The resulting cost of lighting the city streets was found to be far in excess of the present cost. Under the Municipal Electric Co. plan each of the two cities would get half of the power. Minneapolis would thus get only 5,000 hp., which is only one-fiftieth of the total power now used in Minneapolis. Mayor Leach of Minneapolis, however, discountenances the data resulting from St. Paul's investigation, and the city engineer of Minneapolis is now making an independent study for him.

Although Mayor Leach desires to obtain the use of the dam for municipal purposes in both cities, St. Paul is trying to secure it for itself alone, believing that the dam is too small for both cities. St. Paul, moreover, has no intention of using the dam for municipal purposes, but intends to sell the power to industrial plants which would be located in the immediate vicinity of the dam. Thus the cost of carrying and distributing the power over any appreciable territory would be eliminated. Specifically, the Greater St. Paul Committee has invited Henry Ford to construct a plant in St. Paul and utilize the federal high dam. Mr. Ford has already indicated a favorable attitude toward the proposal.

Anticipating the probability, however, that the Federal Power Commission will lease the dam to the Northern States Power Co. because of the latter's greater utilization facilities and greater consequent efficiency, St. Paul is now applying for power rights on the St. Croix River, which runs along the boundary between Minnesota and Wisconsin. The Northern States Power Co. now has the flowage rights, but St. Paul expects to condemn them. St. Paul plans to construct in the St. Croix a dam 75 ft. high yielding 25,000 hp. Because of the cost of carrying the power from the St. Croix to St. Paul, a distance of forty miles, Henry Ford has thus far withheld any statement with regard to the prospect of his utilizing such a dam.

Wisconsin has objected to the St. Croix plan of St. Paul because of the fact that it will mean the condemning of



FEDERAL HIGH DAM IN MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND ST. PAUL, BUILT IN 1914

Wisconsin lands for the use of a Minnesota city. According to the Greater St. Paul Committee, however, Wisconsin does not object to a similar plan on the part of the Northern States Power Co. St. Paul therefore infers that Wisconsin as a state is merely echoing the note of capitalistic interests. The whole matter is now before the Federal Power Commission, from which, it is hoped, a decision will be forthcoming within the next two or three weeks It may be, however, as Minneapolis hopes, that the ccommission will delay action until next year, so that it may take advantage of the decision of Minnesota's next legislative session with regard to the Municipal Electric Company.

The Selection of Prime Movers*

MODERN operating conditions are so diversified and at the same time so specialized, that the selection of the type best suited for an installation is a difficult problem. General rules governing selections are without purpose, since each particular installation is a problem in itself. Floor space, capacity, cost of fuel, water rate, steam pressure, water supply, load characteristics, exhaust-steam requirements, size of foundation, vibration, first cost, attendance, maintenance, depreciation, taxes and interest on the investment, all govern the selection of type. The principal factor governing the size of units is the station load curves; where these curves are known, the problem is a comparatively simple one, but when they must be assumed, as is generally the case with a new project, it is largely a matter of experience.

The piston engine is superior to the turbine for variable speed, slow rotative speeds and heavy starting torque; while the turbine has superseded the engine for large central-station units and for auxiliaries requiring high rotative speed. The high-speed turbine, in connection with efficient reduction gearing, has many advantages over the piston engine for low-speed drives and is rapidly replacing the latter in this connection.

Recent developments in the perfection of the unaflow engine have resulted in remarkably low guaranteed water rates being offered by engine builders. This, with the mechanical efficiency of this type of engine being higher than other types of reciprocating engines, owing to the absence of complicated valve gears, has made the unaflow engine, running non-condensing or condensing, show superior economy over the turbine for sizes up to 600 kw.

Compared with other prime movers, steam turbines have the following principal advantages: Low first cost, require less floor space, lighter foundations and less attendance, have better utilization of high vacuum and lower oil consumption, eliminate reciprocating masses and their resulting vibrations, have no rubbing parts outside of the bearings; they have extreme overload capacity, and freedom of the exhaust steam from oil, increased reliability due to simplicity of construction; excellent regulation and with favorable conditions as regards steam pressure, superheat and vacuum, economies as good as steam engines for moderate powers and much better economies for units of larger sizes and greater powers.

A comparison of the water rates of piston engines and steam turbines is unsatisfactory because of the wide range in operating conditions. In general, the piston engine is more economical in the use of steam than the turbine for non-condensing service and the reverse is true for high-pressure, high-vacuum condensing service. Condensing engines of the unaflow or poppet-valve type have shown superior economy (under favorable conditions) to the turbines for sizes up to 3,000 hp. and, in some instances, up to 5,000 hp., but heat economy is only one of the many factors entering into the ultimate cost of power. For sizes over 3,000 hp. the turbine is in a class of its own.

A general classification of steam turbines is unsatisfactory because of the overlapping of the various groups.

*From report of committee on "Modernization of Stationary Boiler Plants," American Railway Association

STEAM CONSUMPTION OF DIFFERENT TYPES OF ENGINES

TYPE OF ENGINE.	Pounds of Steam per Horsepower per Hour	Steam Pressure, Pounds, Gauge
High-speed simple non-condensing	32	80-100
High-speed compound non-condensing	24-26	150-110
High-speed compound condensing	19-21	150-110
Corliss simple non-condensing	26	80-100
Corliss simple condensing	21	80-100
Corliss compound non-condensing	20-22	150-110
Corliss compound condensing	14-15	150-125
Triple-expansion condensing	13	150-

WATER RATES OF UNIFLOW ENGINES AT VARIABLE LOADS

Rated Capacity	R. P. M.	Initial Pressure Lbs. Abs.	Back Pressure, Lbs. or Vacuum, In.	Superheat, Deg. F.	Lbs. Steam per I. H. P. Per Cent Load				
					25	50	75	100	125
150 K.V.A.	257	110	2 lbs.	0	22.5	21.9	21.5	21.7	22.1
150 K.V.A.	257	110	2 lbs.	0	21.6	20.8	20.6	21.1	.....
150 K.V.A.	225	110	2 lbs.	0	24.8	22.4	21.8	21.9	.....
150 K.V.A.	225	110	2 lbs.	0	23.9	23.2	22.8	22.6	.....
200 K.W.	150	200	1.25 lbs.	0	.....	.....	.....	18.5	19.1
250 K.W.	.....	140	1 lb.	0	18.6	18.4	18.3	18.8	.....
250 K.W.	.....	140	26 in. vac.	0	13.6	13.5	13.7	13.8	.....
400 K.W.	200	200	1.25 lbs.	0	.....	.....	.....	19.7	20.3
525 K.W.	.....	150	2 lbs.	0	.....	.....	.....	19	.....
525 K.W.	.....	150	26 in. vac.	0	.....	.....	.....	14.1	.....
525 K.W.	.....	150	26 in. vac.	150	.....	.....	.....	11.2	.....

WATER RATES OF TURBO-GENERATORS

CONDENSING.				NONCONDENSING.	
Steam at 150 lb. gage, 28 in. Vacuum.		Steam at 200 lb. gage, 150 deg. Superheat, Vacuum.		Steam at 150 lb. gage, Exhaust to Atmosphere.	
Rating Kw	Water rate, lb. per hr. per Kw. incl., Excitation.	Rating Kw.	Water rates, lb. per hr. per Kw. incl., Excitation.	Rating Kw.	Water rate, lb. Per hr. per Kw.
50	32.0 to 42.0	4,000	12.0 to 13.3	50	52.0 to 60
100	21.2 to 27.5	5,000	11.9 to 13.0	100	43.5 to 50
200	19.5 to 25.0	7,500	11.6 to 12.6	200	38.4 to 44
300	18.7 to 22.3	10,000	11.2 to 12.3	300	36.5 to 42
400	18.2 to 21.0	12,500	11.1 to 12.0	400	35.2 to 40
500	17.4 to 19.3	15,000	11.1 to 11.8	500	34.1 to 38
600	17.4 to 19.0	17,500	11.0 to 11.6	600	33.4 to 37
750	17.0 to 18.8	20,000	11.0 to 11.4	750	32.7 to 36
1,000	16.5 to 18.6	25,000	10.9 to 11.3	1,000	31.7 to 35
1,250	16.2 to 18.3	30,000	10.8 to 11.2	1,250	31.0 to 34
1,500	16.0 to 18.0	35,000	10.7 to 11.1	1,500	30.7 to 33
2,000	15.7 to 17.7	40,000	10.5 to 11.1	2,000	30.1 to 32
2,500	15.5 to 17.4	50,000	10.5 to 11.0	2,500	29.4 to 31
3,000	15.4 to 17.1	60,000	10.5 to 10.9	3,000	28.9 to 30
3,500	15.3 to 16.9	75,000	10.4 to 10.8	3,500	28.6 to 29

WATER RATES OF TURBO-GENERATORS AT VARIABLE LOADS

Rating K. W.	Initial Pressure, Lbs. Abs.	Back Pressure Lbs. or Vacuum In.	Superheat Deg. F.	Kilowatt Load.	Pounds Steam Per K. W. H.
100	125	2 lbs.	Dry Sat.	25 50 75 100 125	77.8 60.2 50.0 51.6 47.2
300	175	2 lbs.	100	75 150 225 300 375	56.0 55.3 44.3 38.9 35.7
5,000 Cont. & Max.	150	28 in.	100	2,500 3,000 4,000 5,000	15.93 15.25 14.38 14.41
*5,500 Cont. 11,000 Max.	185	28.5 in.	100	2,000 3,000 4,000 5,000 6,000 7,000 8,000	22.7 20.5 19.5 18.9 18.5 18.39 18.40
*8,000 Cont. 16,000 Max.	185	28.5 in.	100	3,000 4,000 5,000 6,000 7,000 8,000 9,000	17.3 16.8 16.59 16.40 16.28 16.27 16.35
20,000 Cont. & Max.	185	28.5 in.	100	5,000 10,000 15,000 20,000 25,000 30,000	16.1 13.4 12.43 12.13 12.20 12.50
20,000 Cont. & Max.	185	28.5 in.	100	5,000 10,000 15,000 20,000	16.9 14.2 13.25 13.70
20,000 Cont. 25,000 Max.	185	28.5 in.	100	6,000 10,000 15,000 20,000 25,000	15.98 13.50 12.76 13.28 13.90
27,400 Cont. 30,800 hour 40,600 five min.	250	29 in.	150	27,500 40,000	11.25 11.7
37,500 Cont. 45,000 ten min.	200	28.5 in.	150	15,000 25,000 35,000 37,500 45,000	12.85 11.43 12.02 12.20 12.80
41,100 Cont. 46,200 hour 60,900 five min.	250	29 in.	150	41,250 60,000	10.9 11.5
45,000 Cont. & Max.	185	28.5 in.	100	15,000 25,000 37,500 45,000	12.85 11.40 12.20 12.80

* These turbines are of an old type.

The following chart is offered merely as a guide in arranging a few well known turbines according to the fundamental principles involved in their operation.

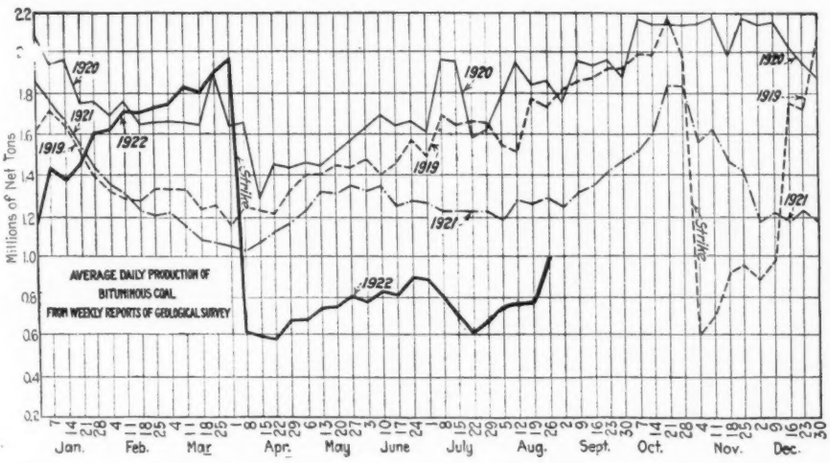
Steam Turbines	Impulse	Single Velocity	De Laval	Single pressure stage
		Multi-velocity Stage	Terry Sturtevant Curtis (Small Type) Westinghouse	
		Single-velocity Stage	Kerr De Laval Rateau	Multi-pressure stage
		Multi-velocity Stage	Curtis	
	Reaction	Multi-velocity Stage	Westinghouse-Parsons Allis-Chalmers-Parsons	
	Combined Impulse and Reaction	Multi-velocity Stage	Westinghouse	

The following grouping shows the most efficient types and sizes of turbines:

Size	Most Efficient Type	Second Best	Third Best
Very small	Impulse	Impulse reaction	Reaction.
Medium and large	Reaction or impulse reaction	Impulse reaction or reaction	Impulse.
Very large	Reaction	Impulse reaction	Impulse.

Bituminous Output Still Below Normal

While the production of anthracite remains practically at zero, bituminous coal is now being mined in ever-increasing quantities, as shown by the accompanying curve of the United States Geological Survey. For the week of Aug. 21-26 over 6,000,000 tons of bituminous were raised. Even with this output, however, present production is still below normal. In the corresponding week of 1921 the country raised 9,640,000 tons of coal, of which 1,890,000 tons was anthracite and 7,750,000 tons bituminous. In the same week of 1920 the total raised was 13,250,000 tons. In comparison with these figures the present weekly output of all coal, anthracite and bituminous, is from four to six million tons short of normal.



Diesel engines are to be installed in six sea-going hopper dredges to be built for the government. It is estimated that the saving will amount to $50,000 per year per dredge, based on 24-hour service. Construction of the vessels at a cost of $750,000 each is authorized in the Senate river and harbor bill. The dredges will have steel hulls and will be used on the Atlantic, Pacific and Gulf coasts.

Government-operated railway lines in Italy will have one-third of their mileage electrified by 1926, if the present definitely formulated program of the Italian State Railway Administration is carried out.

Use Fuel Oil and Coal Mixture During Shortage

A simple mixture of fuel oil with fine coal, in as large a proportion of oil as the coal will absorb and hold, is suggested by the United States Bureau of Mines as an emergency fuel during the present coal shortage.

Slack coal that has a high percentage through an 8-mesh screen, or which may be crushed to sizes of one-eighth inch or less, will take up in oil from 30 to 40 per cent of its own weight and make a fuel high in calorific value. The finer the coal, the larger the amount of oil which it will hold. Bituminous slack or anthracite culm is equally well adapted to the process.

In using such oil-coal mixtures, it has been found that the fire will smoke badly after firing or while breaking up the coke bed from time to time. Tests made by the Bureau of Mines show that careful firing is required to prevent continuous smoking. The best method of firing in each case can be determined only by experiment. The Bureau states that chain grates and certain other automatic stokers are probably well adapted to handle the oil fuel mixtures, if the bin and feeding devices are suitable.

This method is similar to the Trent process of purifying coal by fine grinding and amalgamation with oil, now in operation at a plant at Alexandria, Va., which has demonstrated the success of a combination of oil and coal for steam making, gas manufacturing and other fuel purposes. This process, however, involves a cleaning of the mixture not contemplated in the present emergency proposal, which consists simply of mixing the crude oil and fine coal by shovel or concrete mixer. The Trent Corporation has volunteered its advice to the government in the use or application of oil-coal mixtures, and to waive, during this emergency, any claim of infringement of its process which may or may not be involved by the simple mixing of fuel oil and coal without reference to cleaning.

A million-volt laboratory will be in operation this fall at the California Institute of Technology. Potentials of 1,000,000 volts (and even higher) will be produced by means of four 250-kva. transformers (3,000-6,000/250,000 volts) of Westinghouse manufacture, developed by Prof. R. W. Sorenson. The transformers may be used independently or connected in a variety of ways: (1) 1,000,000 volts with grounded neutral and 500,000 volts line to ground; (2) 500,000 volts step-up-step-down system, neutral grounded; (3) same system, one side grounded; (4) three transformers may be Y-connected with grounded neutral to give 433,000 volts between lines; and (5) single-phase combinations for 250,000 volts may be made.

An experimental transmission line, to operate at 600,000 volts, the highest voltage ever attempted, has been recently constructed at Purdue University, Lafayette, Ind. The purpose of the line is the investigation of corona loss at high voltages, very little being known about corona discharge above 220 kv. The line is about one-third of a mile long, and is supported on 65-ft. steel towers. Two cables of any desired size may be used and provision has been made for varying the horizontal spacing between cables, by suspending them from 40-ft. channel-iron crossarms.

Much can be learned from a study of foreign newspapers that are published in the English language, according to the Water Board of Clarksburg, W. Va., whose secretary and general superintendent, Scotland G. Highland, has prepared a short pamphlet entitled "A Review of the World's English Newspapers," containing also some photographs and information about the Water Board itself. The booklet is of considerable general interest, and may be had from Mr. Highland by anyone interested.

News in the Field of Power

Modern Plant Replaces That Destroyed by Fire

A fire, disconcerting as it may be at the moment, is not always a complete misfortune. Such was the impression gained by a representative of *Power* on a recent visit to the reconstructed shops of the Union Iron Works at Erie, Pa. Early in September the new large boiler shop will be in operation, and in another month the entire plant will be completed and reorganized upon modern lines to turn out high-class work with speed and efficiency.

Great credit is due George W. Bach, the general manager, not only for the excellence of the plant which has been evolved, but for the manner in which production has been kept up with little delay in delivery, with the plant in its crippled condition. One of the expedients by which production was maintained was to run machine tools under rude shelters out in the yard, which the workmen found decidedly more pleasant than working indoors during the hot weather.

Shipping Board Sells Its Diesel Engines

The twenty-seven Diesel engines purchased by the Emergency Fleet Corporation during the war, and for some unexplained reason never installed on shipboard, have been disposed of. The Carry Davis Towing Co., Seattle, Wash., purchased two 320-hp. engines. The War Department purchased thirteen of the 900-hp. engines and two went to the Munson Line. Of the 825-hp. units the Standard Oil Co. bought two, while three went to the Benson Lumber Co., San Diego, one to the Federal Light and Power Co., New York City, and four to bidders whose names are not yet available.

Underfeed Stokers Only for Gennevilliers Extension

The Gennevilliers superpower station at Paris, France[1]—the largest and latest in Europe—was recently visited by Sanford R. Riley, who, during an interview with a member of the *Power* staff, commented on the number of new features in the design of this station. The Riley stokers, in which he was particularly interested, were built in France and are longer than the extra-long type although not as long as the super stoker now being tried out at one of the plants of the Detroit Edison Co. in this country. According to Mr. Riley the workmanship on the stoker has never been excelled. All the gears are cut and the gear boxes are tested individually for efficiency, rise of temperature, etc. On account of the excellent results obtained in France, some of the refinements will be adopted in the American practice of his company. The latest information obtained is that the next addition to the plant will use this type of stoker exclusively in place of the combination of chain grate and underfeed selected for the original installation.

[1]Described in *Power* for Aug. 1 and Aug. 15, 1922.

Superpower Scheme for West Virginia

An hydro-electric development in the heart of one of the largest coal-producing regions of the country is outlined in an application recently received by the Federal Power Commission, covering a comprehensive development of the entire Cheat River in West Virginia and Pennsylvania.

The applicant for the permit, the West Virginia Power and Transmission Co., is understood to be closely allied with the West Penn Power Co., which operates an extensive transmission system throughout the industrial territory tributary to Pittsburgh and Wheeling. It is planned to create a small superpower project in this region, by developing all the available power on the Cheat River and establishing interconnection with existing steam plants of the West Penn Power Co.

The West Virginia Power and Transmission Co. already has a permit from the War Department for a large development near the state line between Pennsylvania and West Virginia, and it is now asking the Federal Power Commission for a permit to cover ten additional developments which will utilize all the fall of the Cheat River and practically all the reservoir sites along that stream. The primary power available is estimated at 200,000 hp., but equipment capable of developing at least 500,000 hp. will be installed.

A novel feature of this development lies in the fact that instead of using steam as an auxiliary to water power, the intention is to use the water power to take the peaks of the steam load.

Public Service Company To Build Waukegan Plant

A generating station of 250,000-kw. ultimate capacity will be built by the Public Service Co. of Northern Illinois at Waukegan, forty miles north of Chicago. Ground was broken on Sept. 1, and it is expected that the first unit of 25,000 kw. will be in operation by next August. Space for two units will be provided in the first building, the second unit to be of 30,000 to 35,000-kw. rating. The site comprises 87 acres, in the center of which is a natural pond of 11 acres. An intake from Lake Michigan will provide a steady water supply.

Oklahoma's Largest Power Plant To Develop 10,000 Hp.

The largest power plant in the State of Oklahoma is now being built on the east bank of the Arkansas River, four miles northeast of Muskogee. An initial installation of one 7,500-kw. turbine is planned, with space for a second turbine of equal rating. The capacity of the existing Muskogee plant of the Oklahoma General Power Co., is 4,600 hp. This company is now controlled by H. M. Byllesby & Co. The cost of the new plant is set at $2,000,000, and two years will be required for its construction.

Ford To Enlarge Power Plants Will Build Own Turbines

Owing to enormous production and the ever increasing demand for Ford cars and tractors and to the fact that factory current is no longer purchased, it has become necessary to add materially to power plant capacities.

At the River Rouge plant, contracts have been placed to complete the boiler room as originally planned (see *Power* for Nov. 1, 1921). The initial installation consisted of four double-ended Ladd boilers each containing 26,470 sq.ft. of steam-making surface and fired by both pulverized fuel and blast-furnace gas. The final four boilers are now on order; they will be identical in size and design with those now in use.

To provide full capacity, the two-effect high-heat-level evaporator system is to be completed as originally laid out for the eight-boiler plant. It will contain fourteen first-effect and fourteen second-effect evaporators. The initial installation included nine of these units.

For the generating end of the plant plans have not been fully developed, but the present intention is to install two 30,000-kva. turbo-generators designed to deliver three-phase 60 cycle current at 4,600 volts, thus conforming with the two 12,500-kw. machines now in service. At a later date these smaller machines may be replaced by two more of the large units, giving a total capacity of approximately 100,000-kw. It is planned to build the new turbo-generators in the company's shops, where successful machines of smaller size already have been turned out.

Two additions to the nation-wide chain of Ford factories and assembling plants will show further evidence of Ford workmanship in their power plant equipment. At Ford City, where a new factory will turn out 500, and ultimately 2,000 cars a day, a powdered coal system of Ford manufacture will fire the boilers. Likewise, in the new assembling plant at Kearney, N. J., fuel oil

will be burned in a system of Ford design. Both of these plants will be equipped with turbo-generators built in the company's shops.

It is stated that the impending shutdown of all the Ford plants on September 16, due to the coal shortage, will not deter the company from carrying to completion these changes and additions to its power-plant equipment.

Pennsylvania bituminous coal fields contain enough coal to meet the demands of the next 290 years at the present rate of consumption, according to a recent survey of the Bureau of Topographic and Geological Survey. The amount of recoverable coal is placed at 43,830,900,000 short tons.

New Publications

Machinists' & Draftsmen's Handbook. By Peder Lobben, M. E. Published by D. Van Nostrand Co., 8 Warren St., New York City. Third edition, revised; flexible cloth cover; 4½ x 7½ in.; 487 pages. Price, $3.

A revised edition containing tables, rules and formulas in mathematics and mechanics, useful to all engaged in the mechanical trades. The author avoids entirely the use of calculus, thereby rendering his book of maximum value to the men for whom it was written. The third edition includes no changes of importance, aside from the alteration of the electrical formulas to conform to the new standardization rules.

The Standard Handbook for Electrical Engineers. Frank F. Fowle, Editor in Chief. Published by McGraw-Hill Book Co., Inc., New York, 1922. Flexible leather binding; size 4x7 in.; 2,139 pages; illustrated. Price $6.

This is the fifth edition of this handbook, which has been enlarged, revised, and brought up to date. In the preparation of this edition the general arrangement and make-up of the fourth edition have been retained without change, and the general policy adopted in the previous edition has also been followed. The fourth edition contained 1,946 pages, therefore space limitations have prevented any extensive enlargement of the new edition. There have been substantial changes made in every section with the exception of Nos. 1, 23 and 25. A few of the sections have been rewritten in large part; this applies particularly to sections 11, 14 and 17, which deal with power transmission, illumination, electric vehicles. New articles have been added to the sections on industrial-motor applications and miscellaneous applications of electricity.

In the fourth edition the index was contained in 67 pages. In the new edition this has been expanded to 121 pages, and an effort has been made to make this index as comprehensive as space limitations would permit. As the title of this handbook indicates, it has been compiled for electrical engineers. Probably the best indication of its usefulness to this class of readers is that a total of about 64,000 copies of the five editions has been sold.

Personals

John T. Simmons is now sales manager of the Worthington Water Tube Boiler Department of the New Brunswick Iron Works, New Brunswick, N. J. Mr. Simmons was formerly with James Beggs & Co., New York City, owners of the Worthington Tube & Boiler Co., before the recent transfer to the control of the New Brunswick Iron Works. Mr. Simmons has a wide acquaintance in the engineering field, and a technical education which eminently fits him for his present position.

Coming Conventions

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Des Moines, Ia., Sept. 11-16. Annual conventions and exhibitions of the State Associations scheduled as follows:
Iowa, at Des Moines, Sept. 10-11; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.
International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention and exhibition at Minneapolis, Minn., Sept. 11.
Association of Iron and Steel Electrical Engineers, 1007 Empire Bldg., Pittsburgh, Pa. Annual convention and exhibition at Cleveland, Ohio, Sept. 11-16.
New England Water Works Association, Boston. Annual convention at New Bedford, Mass., Sept. 12-15.

Business Items

The Reeves Pulley Co., Columbus, Ind., is now represented in the New England territory by Manning, Maxwell & Moore, Inc., 99 Chauncey St., Boston, Mass., which concern will handle "The Reeves" variable speed transmission.

The Johns-Pratt Co., Hartford, Conn., has elected Arthur Ward Fox as vice-president and general manager. Mr. Fox's former position was that of secretary and assistant treasurer. He has been associated with the company for sixteen years, starting as a clerk and working up through the various departments. His office will be at the factory, Hartford, Conn.

Trade Catalogs

Steam Traps — Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Bulletin P-1701, 4 pages, showing clearly the operation of the Yarway Steam Trap, and giving tables of prices and dimensions, capacities and weights.

Ash Conveyors — United Conveyors Corp., 1,500 Old Colony Bldg., Chicago, Ill. Bulletin No. 105, a new 32-page catalog, containing information on the United Steam Jet Conveyor relating to its development, steam consumption, application, practical points on installation, first costs, costs of operation and maintenance, and special features of the design. Use of the conveyor for handling soot, broken coal, coke, refuse and dust is also given mention and some space devoted to hollow-tile reinforced ash-storage tanks.

Wood Split Pulleys—Reeves Pulley Co., Columbus, Ind. Catalog P-33, 31 pages, describing and showing the construction of the company's line of wood split pulleys, wood split pulley clutches, and the variable speed transmission.

Boilers—John Mohr & Sons, 96th St. and Calumet River, South Chicago, Ill. An 8-page pamphlet bringing out the features of the new Burton "Duplex" water-tube boiler. This is a double-drum sectional boiler occupying low headroom.

Boiler Damper Control—Northwestern Manufacturing Co., Milwaukee, Wis. A catalog of the Northwestern company's damper regulator for automatically maintaining constant draft pressure. This damper control was described in *Power* for Aug. 22, 1922, on p. 289.

Fuel Prices

FUEL OIL

New York—Aug. 31, Port Arthur light oil 22@25 deg. Baumé 4c. per gal.; 30@35 deg., 5c. per gal. f.o.b. Bayonne, N. J.

Chicago—Aug. 19, for 24@26 deg. Baumé, $1.50 per bbl.; 32@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Aug. 22, f.o.b. refinery, Pennsylvania, 36@40 deg., 6¼c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg. 3¼c. Western, 24@30 deg., $1.30@$1.35 per bbl.

Philadelphia—Aug. 21, 26@28 deg. Baumé, Oklahoma, 90@95c. per bbl.; 30@34 deg., Oklahoma (group 3), 2¼@2½c. per gal.; 16@20 deg. Seaboard, $1.35@$1.50 per bbl.

Cincinnati—Aug. 21, for 26@28 deg. Baumé, 5¼s.; Diesel, 28@30 deg. 5½c. per gal.; distillate 38@40 deg., 6c.

Cleveland — Aug. 21, 26@28 deg. Baumé, 4¼c. per gal.

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

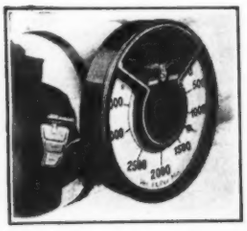
Coal	Market Quoting	Aug. 21, 1922	Aug. 28, 1922
Pool 1,	New York	.....	.....
Smokeless,	Columbus	$4.50–7.50	$4.00–7.50
Clearfield,	Boston	7.00–8.25	5.50–6.25
Somerset,	Boston	7.50–8.50	5.50–6.50
Kanawha,	Columbus	4.50–8.00	3.75–7.50
Hocking,	Columbus	4.50–8.00	4.00–7.75
Pittsburgh No. 8	Cleveland	5.00–7.25	5.00–5.50
Franklin, Ill.,	Chicago	.....	4.50–4.75
Central, Ill.,	Chicago	.....	4.25–5.00
Ind. 4th Vein,	Chicago	.....	4.65–5.00
West Ky.,	Louisville	4.50–7.50	4.50–5.50
Big Seam,	Birmingham	2.50–6.00	4.00–5.00
S. E. Ky.,	Louisville	3.50–7.00	4.50–5.75

Condensed-Clipping Index of Equipment

Condensed from previous descriptions in "Power" for convenient filing

Meter, Air-Flow "Power," 1922.

Stratton Engineering Laboratories, Chicago, Ill.



An air-flow meter with a possible application in the boiler room with forced-draft stokers of the underfeed type. The vane hanging in the middle of the pipe, as shown in the illustration, may be pushed through an angle of 42 deg., according to the velocity of the flow in the pipe. The shaft on which this vane is mounted has a pulley on its other end, which is connected by a silk fishline to a smaller pulley, which turns the pointer of the instrument. The pointer swings through 284 deg. for the 42-deg. movement of the vane. The glass cover is fastened tightly, and pressure is admitted to the inside of the instrument, thus eliminating the necessity of stuffing boxes. With the meter is furnished a pressure gage of suitable length to conform to mercury, water or oil column reading. The range may be from 350 ft. per min. up to 2,000 ft. per min., or from 1,200 to 6,000 ft. per min.; or the dial may, of course, be calibrated in any other way desired. Described further in "Power" for March 7, 1922, page 387.

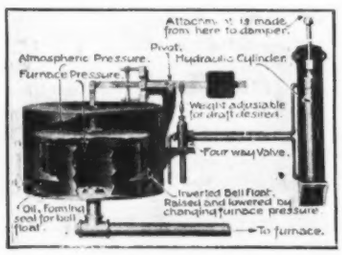
Switches, Pressure Operated "Power," 1922.

Federal Gage Co., Chicago, and Marshalltown Manufacturing Co., Marshalltown, Iowa.

A low-voltage electric switch that is operated by changes in pressure. It uses the familiar principle of the Bourdon tube, together with a novel type of switch that opens and closes the circuit by the movement of mercury in a sealed glass tube, shown in the center. The two electrical contacts are placed near each other in one end of this tube, and when it is tipped as shown in the illustration, the mercury rolls down and short-circuits the contacts; when it is tilted the other way, the mercury rolls to the other end and breaks the circuit. The tube is tilted by the ring-shaped Bourdon tube, the ends of which tend to draw apart when the pressure inside of it increases. Described further in "Power" for March 28, 1922, page 506.

Regulator, Furnace "Power," 1922.

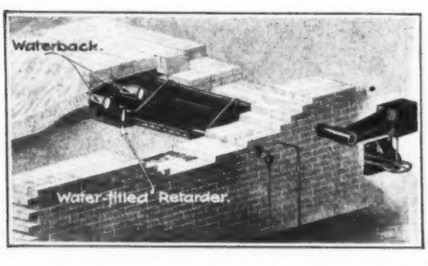
Carrick Engineering Co., Chicago, Ill.



An automatic furnace regulator of the gasometer type, depending for its operation upon the furnace draft and designed principally for use with forced-draft stoker installations for controlling each boiler individually, or to be used in combination with the company's steam-operated master regulator. The latter practice is recommended. The pressure or vacuum being carried in the furnace acts upon the inside of the bell float shown in the illustration, raising and lowering it as it varies, and thus operating a four-way valve that lets water into the top or bottom of the hydraulic cylinder shown at the right. A piston in this cylinder operates a damper in the breeching or in the forced-draft air duct. Described further in "Power" for March 14, 1922, page 421.

Retarder, Fuel "Power," 1922.

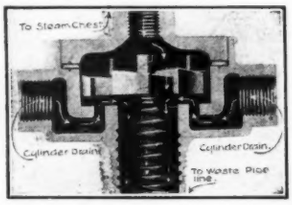
Green Engineering Co., 40 Kennedy Ave., East Chicago, Ind.



An adjustable device to be used with chain-grate stokers for maintaining a compressed fuel bed, for keeping excess air from getting in over the rear end of the grate and for controlling the ashpit losses. It spans the grate just back of the ordinary stationary waterback; the turning of a wheel outside the setting changes the distance between the lower edge of the fuel retarder and the surface of the grate from a minimum opening of 1½ in. to a maximum of 6 in. To the advantages of the water-back, therefore, the fuel retarder adds the advantage of flexibility to meet varying conditions of firing. Described further in "Power" for March 21, 1922, page 459.

Valve, Automatic Drain "Power," 1922.

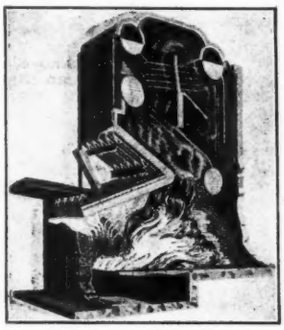
Diel-More Sales Co., Bourse Bldg., Philadelphia, Pa.



A relief valve for use with all kinds of reciprocating steam equipment, which automatically drains the cylinder when the throttle is closed, making it unnecessary for the engineer to open and close the cylinder drain valve. The drain pipes from the two ends of the cylinder are brought down just below the cylinder and connected to the valve body at both sides, thus letting full steam pressure into the valve chamber, tending to lift the valve disc. If the throttle is opened, however, the disc will be held down by steam pressure that is let in above it through a pipe from the steam chest. This pressure is a little higher than that in the cylinder itself, and so the disc stays down. When the throttle is closed, however, and the engine is stopped, the pressure on both sides of the disc is relieved and the spring under it raises it, thus allowing the escape of condensation. Described further in "Power" for April 4, 1922, page 541.

Furnace, Bagasse Burning "Power," 1922.

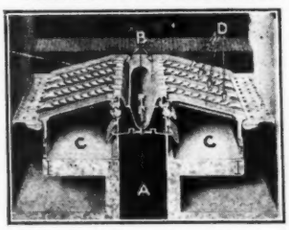
W. A. Gilchrist, Peoples Gas Bldg., Chicago, Ill.



This furnace has been designed particularly to burn bagasse, which is the name applied to the shredded remains of cane after the sugar has been extracted. This fuel is difficult to burn, having a moisture content running from 45 to 55 per cent; the heat value ranges from 3,700 to 4,500 B.t.u. per pound, and over 8,000 B.t.u. when dry. It is fed into the furnace at the top, forming a cone-shaped pile in which three separate operations take place at the same time. At the top of the cone the moisture is being driven off; at the middle, where the fuel has been dried, the volatile matter is being driven off; at the bottom is a bed of burning charcoal. Balanced draft is used. Described further in "Power" for May 16, 1922, page 784.

Stoker, "Industrial" "Power," 1922.

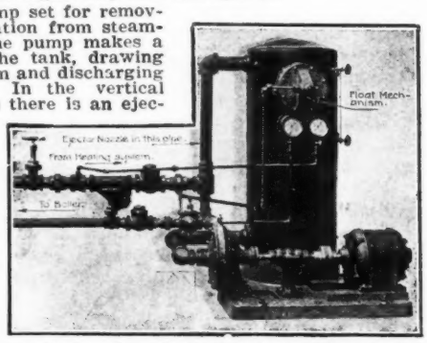
United Machine and Manufacturing Co., Canton, Ohio.



An underfeed stoker incorporating several features not previously applied to this type. There is an independent control of the air supply to the thick central part of the fire and to the thinner parts at the sides. *A* is the central high-pressure air duct that feeds air through the perforated tuyere heads *B* into the thickest part of the fire. On both sides of the central duct are secondary chambers *CC* into which air passes from the central duct, in the quantity desired, through dampers. By means of the dampers the proportion between the air supplied to the central part of the fire and to the sides can be regulated. To keep the coal agitated in the central retort, both rows of tuyeres *B* are moved back and forth horizontally at right angles with the retort. Alternate tuyeres are in one piece with the stepped grate bars *D*, and so the latter move back and forth also. Described further in "Power" for March 14, 1922, page 419.

Pump Set, Motor "Power," 1922.

Young Pump Co., Michigan City and Chicago, Ill.



Motor-operated pump set for removing air and condensation from steam-heating systems. The pump makes a closed circuit with the tank, drawing water from the bottom and discharging back into the top. In the vertical pipe above the pump there is an ejector-type nozzle about 20 in. long, through which the water passes, thus drawing the air and condensation into the tank. Air escapes through a vent, and as the water level rises a float-operated valve allows some water to be forced back into the boiler. An automatic vacuum control may also be provided. Described further in "Power" for April 4, 1922, page 536.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)

New Plant Construction

PROPOSED WORK

Calif., Macdoel—The Butte Valley Irrigation Dist., E. Bissell, Secy., will soon call bond election to vote on constructing works to irrigate about 30,000 acres, pumping plants, canals, etc. C. T. Darling, Klamath Falls, Ore., Chief Engr.

Calif., Napa—The city voted $600,000 bonds, $265,000 of which will be used to purchase system of Napa City Water Works, balance to be used for improvements, including single arch concrete dam with gravity section, 108 ft. high and 600 ft. long at top, storing 630,000,000 gal.; cost, including outlet and control works and spillway, $220,000; pipe line from diversion dam in Milliken Canyon to proposed reservoir, 25,600 ft. 4 in. double dipped, riveted steel slip joint pipe, 1,600 ft. 16 in. machine-banded, dipped r.w. stave pipe, pressure break, valves etc., fittings, etc., estimated cost of pipe and fittings, $52,000; chlorinator for sterilizing water, installed at reservoir, $3,000. H. A. Harrold, City Engr.; A. Kempkey, Hobart Bldg., San Francisco, Consult. Engr.

Calif., Sacramento—The State Dept. Pub. Wks., Div. of Architecture, will receive bids until Oct. 3, for mechanical equipment for the State Buildings. Noted Aug. 1.

Calif., San Anselmo—Marin County Sanitary Dist. 1, Bd. Directors, will receive bids until Sept. 8 for Contract 1, furnishing and installing pumps, motors, switches and control apparatus, electric wiring and lights for sewage pumping plant, consisting of 3 pumps, 450 gal. per min. against head of 12 ft. direct connected to three 60 cycle, 3 phase, 220 volt, 5 hp. motors with automatic starting equipment; Contract 2, furnishing and installing automatic chlorinator, capacity 75 lbs. of chlorine per 24 hrs.; Contract 3, constructing sewage plant, including sewage treatment tanks, pump house, flume, chlorination house, sludge beds and outfall sewer line to Corte Madera slough.

Colo., Loveland—The city plans the construction of a hydro-electric plant, 1,125 kva. capacity, on Big Thompson River in Loveland Canyon. Estimated cost $400,000. L. C. Osborn, Engr. R. Smith, Longmont, will purchase machinery.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson Blvd., will soon receive bids for a 4 story, 110 x 275 ft. furniture factory, including steam heating system, on George St. and North Crawford Ave., for the Valentine-Seaver Co., 1721 Sedgwick St. Estimated cost $1,000,000.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson Bldv., is having plans prepared and will soon receive bids for a 3 story, 100 x 300 ft. candy factory, including steam heating system, on Cicero and Kinzie Sts., to be built in three units, for Brach & Sons, 215 West Ohio St. Estimated cost $1,000,000.

Ill., Chicago—A. G. Lund, Archt., 453 West 63rd St., is receiving bids for a 3 story, 125 x 177 ft. apartment building, including steam heating sysetem, on 67th and Merrill Sts., for J. S. Smith, 6720 Clyde Ave. Estimated cost $250,000.

Ill., Lake Forest—The North Shore Sanitary Dist. of Lake County, Bd. Trustees, Rm. 295 Anderson Bldg., will receive bids until Sept. 28 for 2 sewage treatment plants, including pumping stations, settling tanks, sludge beds, sprinkling filters, earth work, etc., at the lake in Highland Park, Deerfield Twp., at ft. of Park Ave., and at Lake Bluff, Shields Twp., at ft. of Prospect Ave. Pearse, Greeley & Hansen, 39 West Adams St., Chicago, Consult. Engrs.

Ill., Maywood—P. E. Weise is in the market for a 50 hp. steam boiler (used).

Ill., Wilmette—The Beach Manor Real Estate Improvement Co. plans to build a 9 story, 225 x 225 ft. apartment hotel. Estimated cost $1,500,000. R. L. Simons, Elkhart, Archt.

Ind., Bedford—The Indiana Quarries Co., plans to build a 1 story stone mill. Estimated cost $300,000. Architect not selected.

Ind., Fort Wayne—The Bd. Educ. plans to build a 1 story school (McCullough). Estimated cost $250,000. G. Mahurin, Lincoln Life Bldg., Archt.

Ind., Indianapolis—Dr. D. W. Fossler, Hume-Mansur Bldg., is having revised plans prepared for a 10 story, 67½ x 195 ft. physicians building on North Pennsylvania Ave. Estimated cost $800,000. D. Graham, Hume-Mansur Bldg., Archt.

Ind., Indianapolis—G. J. Marott, 18 East Washington St., plans to build a 10 story hotel on North Meridian St. Estimated cost $1,500,000. Vonnegut, Bohn & Mueller, 610 Ind. Trust Bldg., Archts.

Ia., Cedar Rapids—The Bd. Educ., J. A. Motejl, Secy., will receive bids until about Sept. 20 for a 3 story, 160 x 200 ft. junior high school, including steam heating system, and equipment for vocational departments. Estimated cost $475,000. B. Rugh, 811 Security Bldg., Archt. F. Tustison Co., 322 Auditorium Bldg., Minneapolis, Minn., Engrs. Noted Aug. 15.

Kan., Wichita—The Public Market Co., 124 West Douglas Ave., is in the market for an 8 ton ice machine.

Me., Portland—The Confederated Home Abbatoir Corp. is having plans prepared for a 4 story meat packing plant, ice manufacturing and refrigerating plant. Estimated cost $300,000. Gorman & Brown Engr. Co., 357 Westminster St., Providence, R. I., Engrs. Noted June 13.

Md., Baltimore—E. H. Glidden, Archt., 1210 American Bldg., received bids for a group of 9 buildings, administration, 3 pavilions, nurses home, kitchen, laundry, power house and garage, including equipment, on Hartford Rd., also excavations, grading, roads, sewers, etc., for the Baltimore City Hospital for Communicable Diseases, from the Price Constr. Co., Maryland Trust Bldg., $645,900; R. B. Mason, 308 West Madison St., $653,000; M. A. Long Constr. Co., 2016 West North Ave., $671,987.

Mass., West Springfield, (Springfield P. O.)—The Wico Electric Co., P. Brown, Pres., 44 Avon Pl., Springfield, plans to build the first unit of plant for the manufacture of electrical goods to consist of four 1 story buildings, 90 x 400 ft. Architect not announced.

Mich., Detroit—J. W. Wilson, Archt., 17 Campus Martius, plans to build a 7 story, 115 x 155 ft., apartment building, including steam heating system, on Marquette and Jefferson Aves. Owner's name withheld.

Mich., Detroit—H. Yannover, 1036 East Kirby Ave., plans to build a 10 story, apartment building, including steam heating system, on Seward Ave. Kohner & Seeler, 1402 Kresge Bldg., Archts. Owner's name withheld.

Minn., Eveleth—The city is having plans prepared for a 5 story hospital, including steam heating system. Estimated cost $700,000. E. H. Berg, Archt.

Minn., Kenyon—The village, O. C. Strand, Recorder, is having plans prepared for a 300,000 gal. capacity reservoir and high service pump. Estimated cost $15,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Engr.

Minn., Thief River Falls—The city, A. H. Akre, Clk., will receive bids until Sept. 12 for filtration plant, 1,000,000 gal. capacity, including filter plant building, filter and pumping equipment, motor house, etc. Estimated cost $30,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Minn., Engr. Noted July 25.

Mo., Kansas City—The Bd. Educ. plans to build a 2 story, 80 x 104 ft. school, including swimming pool and boiler room, on 11th and Harrison Sts. C. A. Smith, 602 Finance Bldg., Archt.

Neb., Omaha—Judge A. Sears, 448 Brandeis Bldg., is having plans prepared for a 10 story club and office building on 18th and Dodge Sts. Estimated cost $1,500,000. McDonald & McDonald, 204 Standard Oil Bldg., Archts.

N. J., Camden—The J. B. Van Sciver Co., Front and Federal Sts., plans to build a 32 x 50 ft power house in connection with new furniture factory. Ballinger Co., 105 South 12th St., Phila., Pa.., Engrs.

N. J., Hackensack—The Hackensack Improvement Comn., will receive bids until Sept. 25 for Contract 3 sewage pumping equipment, consisting of A. B. Wood patent trash pumps, motors and switchboards, to be installed in structures to be build for the city under contract 1. L. Lozier, Rm. 3, Bank Bldg., Main and Mercer Sts., Engr.

N. J., Trenton—The State Bd. Educ., State House, will receive bids until Sept. 7 for a 32 x 86 ft. power house with underground pump and coal room addition, to house high pressure steam plant, electric generators, refrigerator plant, etc., for the State Normal School on Model Ave. Guilbert & Betelle, 546 Broad St., Newark, Engrs.

N. Y., Buffalo—The Bd. Educ., 1401 Telephone Bldg., will receive bids until Sept. 11 for a 3 story, 175 x 250 ft. school 69, on Clinton St. Estimated cost $400,000. Associated Buffalo Archts., 232 Delaware Ave.

N. Y., Glens Falls—The Bd. Educ., will receive bids until Sept. 18 for school. Estimated cost $250,000. Tooker & Marsh, 101 Park Ave., New York, Engrs.

N. Y., New York—Kovat & Knauber, 800 Edgewater Rd., are in the market for an air compressor, about 100 cu.ft. capacity.

N. Y., New York—Rouse & Goldstone, Archts. and Engrs., 512 5th Ave., are preparing plans for a 9 story, 78 x 95 ft. apartment building, including a steam heating system at 45 Park Ave., for the 45 Park Ave. Corp. Estimated cost $700,000.

N. Y., Port Jervis—The Bd. Educ., will receive bids until Sept. 12 for a high school. Estimated cost $400,000. Tooker & Marsh, 101 Park Ave., New York, Engrs. Noted June 6.

N. Y., Rochester—The National Bank of Commerce, State St., will soon award the contract for a 5 story, 85 x 85 ft. bank and office building on State and Corinthian Sts. Estimated cost $500,000. J. F. Warner, 1036 Granite Bldg., Archt.

N. Y., Saratoga Springs—The Bd. Educ. will receive bids until Sept. 18 for a high school on Lake Ave. Estimated cost $400,000. Coffin & Coffin, 522 5th Ave., New York, Archts and Engrs. Noted Apr. 25.

N. Y., Tonawanda — The Tonawanda Board & Paper Co., M. W. Simon, Pres., plans the construction of a water power plant, 1,000,000 gal. capacity, in connection with factory.

N. C., Fayetteville—The Carolina Power Co., P. A. Tillery, Supt., Raleigh, plans the construction of a 40 mi., 100,000 volt steel tower transmission line from Laurenburg to here, to furnish 15,000 hp.

Ohio, Cincinnati—The Brotherhood of Railway and Steamship Clks., Freight Handlers, Express and Station Employees are having plans prepared for a 7 story, 90 x 120 ft. office and lodge building on Vine and Court Sts. Estimated cost $500,000. Rendigs, Panzer & Martin, 609 Lincoln Inn Court, Archts.

Ohio, Cleveland—The Cleveland Medical Library Assoc., c/o Dr. G. E. Follansbee, 9615 Miles Ave., plans to build a 3 story medical library, including steam heating system, at 2318 Prospect Ave. Estimated cost $400,000. Walker & Weeks, 1900 Euclid Ave., Archts.

Ohio, Dayton—The Miami Ice & Fuel Co., Ludlow Bldg., plans to build a 4 story, 60 x 160 ft. cold storage plant. Estimated cost $150,000. Architect not selected.

Ohio, Martins Ferry—The city will vote on $400,000 bond issue Nov. 7, for the reconstruction of the municipal electric light plant and waterworks. J. N. Chester, Union Bank Bldg., Pittsburgh, Pa.

Ohio, West Park—The Bd. Educ., O. Juergens, Clk., West 152nd St. and Lorain Ave., Cleveland, plans to build a 3 story high school, including steam heating system. Estimated cost $600,000. Architect not selected.

Pa., Altoona—The Blair Ice & Cold Storage Co., c/o F. H. Seeley, 3124 5th Ave.., plans to build a 3 story, 60 x 100 ft. cold storage plant. C. F. Baker, Atlanta, Ga., Archt.

Pa., Dallas—The Sisters of Mercy Convent, J. L. Morris, Chn. Bldg. Com., Coal Exchange Bldg., is in the market for complete equipment for new 50 x 76 ft. power house.

Pa., East Greenville—The Boyertown Burial Casket Co. plans to build an electric light and power plant to supply its works.

Pa., Grove City—E. G. Herschaw, c/o 1st Natl. Bank, plans to build a hotel at Carruthers Park. Estimated cost $150,000. Architect not selected.

Pa., Middletown—The Middletown Ice Co. is in the market for complete machinery and equipment for proposed large ice manufacturing plant on Race St.

Pa., Phila.—The Bd. Educ., 19th and Chestnut Sts., will receive bids until Sept. 7 for a 3 story school, including heating and ventilating systems, etc., on Palmetto and Bleigh Sts. Estimated cost $500,000. Private plans.

Pa., Phila.—C. J. Cumminsky, Archt., 118 West Sharpnack St., is receiving bids for a 3 story, 100 x 184 ft. school, including steam heating system, on 24th and Wallace Sts., for St. Francis R. C. Church, 24th and Green Sts. Estimated cost $250,000.

Pa., Phila.—The Logan Ice Co., C. W. Roberts, Purch. Agt., 10th and Windrim Sts., is in the market for ice manufacturing machinery for new plant.

Pa., Phila.—The Standard Provision Co., A. Rabinowitz, Purch. Agt., 212 North Front St., is in the market for conveyors, refrigerating machinery, steam kettles, etc., for packing house.

Pa., Pittsburgh—The Homeopathic Hospital, Center Ave., plans extensions and additions consisting of various buildings. Estimated cost $1,000,000. Architect not selected.

Pa., York—The York Mfg. Co. plans to build a 5 story, 60 x 100 ft. plant for manufacture of ice and refrigerating machinery. Estimated cost $300,000. Architect not announced.

Va., Kenbridge—T. H. Allen is in the market for coal loading and conveying machinery.

Wash., Seattle—The B.P.O.E., 4th and Spring Sts., plan to build a 300 room hotel with auditorium (3,000 seating capacity) on 4th and Madison Sts., adjoining present building. Estimated cost $1,000,000. Architect not selected. J. C. Slater, Chn. Bldg. Com.

Wis., Fort Atkinson—The city, W. D. Leonard, Clk., plans to install equipment at waterworks, including heavy duty air compressor, air lift pump and auto truck pumper. Estimated cost $38,000. W. J. Kirchoffer, Vroman Blk., Madison, Engr.

Wis., Green Bay—The Fort Howard Paper Co., South State St., plans to build a 3 story, 100 x 140 ft. paper finishing factory. Estimated cost $200,000. Private plans.

Wis., Kenosha—Kenosha County is having revised plans prepared for a 3 story, 126 x 226 ft. and 67 x 138 ft. courthouse, and administration building and jail, on Sheridan Rd. Estimated cost $650,000. Lindl, Lesser & Schutte, Wisconsin St., Archts.

Wis., Milwaukee—The Juneau Park Surf Co., c/o E. B. Woolf & Co., 79 West Monroe St., Chicago, Ill., plan to build an 8 story apartment hotel on Juneau Pl., here. Estimated cost $1,500,000. Hetherington & Krieg, 80 West Washington St., Chicago, Ill., Archts.

Wis., Plymouth—The Phenix Cheese Co., R. A. Harbach, Mgr., is having preliminary plans prepared for a 5 story, 30 x 60 ft. addition, also 2 additional stories to present factory building. Estimated cost $60,000. Private plans. Refrigeration machinery of several tons capacity and steam power equipment 300 hp. will be installed.

B. C., Vancouver—The city council has appointed J. G. G. Kerry, Engr., M.E.I.C. of Kerry & Chace, Ltd., Confederation Life Bldg., Toronto, Ont., to investigate hydro electric facilities here with a view to establishing a municipal hydro electric plant.

Ont., London—The London Curling Club, F. Ashplant, Secy., plans to rebuild curling rink, which was destroyed by fire and install an artificial ice plant.. Estimated cost $75,000.

Ont., Niagara Falls—The Ontario Hydro Power Comn., c/o Sir Adam Beck, London, plans to make repairs to generator in power house, damaged to the extent of $70,000.

Que., Asbestos—Johns Manville Co., Ltd., 450 St. James St., Montreal, report that they plan the erection of a plant, including required machinery, here, to take care of all Canadian requirements. Estimated cost $1,000,000.

Que., Iberville—The town, O. Beaudouin, Purch. Agt., 71 A St. James St., Montreal, is in the market for mechanical gravity filtration plant, 500,000 gal. capacity, steel hemispherical tank, 100,000 gal. capacity, and 4 centrifugal pumps.

H. T., Honolulu—The Castle Cook Steamship Co., Ltd., is having plans prepared for a 3 story, store and office building. Estimated cost $420,000. C. W. Dickey, 2149 Broadway, Oakland, Calif., Archt.

N. Z., Wellington—The Pub. Wks. Tenders Bd. will receive bids until Nov. 21 for Mangahao Electric Power Plant, Section 24, storage battery and booster, 116 cells complete, 12 hydrometers, 2 cell voltmeters, 4 spare cells complete, 1 motor booster complete with rheostat and starter; Section 45, testing transformer, testing transformer complete, regulator complete, switchboard, spheregap and oil.

CONTRACTS AWARDED

Calif., Berkely—The University of California awarded the contract for a 2 story, 70 x 186 ft. building, to be known as Haviland Hall, to K. E. Parker, Clunie Bldg., San Francisco, $337,400. Noted Aug. 22.

Calif., Oakland—The Bd. Educ. awarded the contracts for a vocational high school as follows: general to R. W. Littlefield, Everson Bldg., $179,700; heating and ventilating to Scott Co., 243 Minna St., San Francisco, $28,578; equipment to S. Kulchar, 8th Ave. and East 10th St., $19,500. Noted July 18.

Conn., Hartford—The Automatic Refrigerating Co., 618 Capitol Ave., awarded the contract for a 3 story, 53 x 71 x 95 ft. addition to plant, to M. A.. Connor, 668 Broadview Terrace. Estimated cost $50,000.

Conn., Robertsville (Colebrook P. O.)—The Winsted Gas Co., Winsted, awarded the contracts for a power plant at Robertsville Falls and the construction of a 300 ft. canal, 15 ft. deep, to J. M. Swan & Son, Inc., St. Johnsbury, Vt., estimated cost $30,000; two 300 hp. water wheels complete, to L. B. Dow & Son, Ayre, Mass.

Ill., Chicago—The Judson Hotel Co., c/o H. L. Stevens & Co., Archts.., 30 North Michigan St., awarded the contract for a 10 story, 100 x 136 ft. apartment hotel at 5032 Sheridan Rd., to the B. W. Construction Co., 726 Cass St. Estimated cost $1,250,000.. A steam heating system will be installed. Noted July 18.

Ia., Mason City—The city, C. J. DeLacy, Secy. Power & Light Bd., awarded contracts as follows: one horizontal steam surface condenser, to J. W. Hildred & Co., 1019 Commerce Bldg., St. Paul, Minn., $1,800; one exhaust steam feed water beater to R. B. Whitacre & Co., 205 South Robert St., St. Paul, Minn., $1,300; one steam driven air compressor, 1,500-2,500 capacity, to the Murray Iron Works, Burlington, $12,500. City will build foundations and install the above. Noted July 18.

Kan., Kansas City—The City Ice Co., 21st and Campbell Sts., awarded the contract for a refrigerating plant, 3,000 ton capacity, also a car icing platform, on Muncie and 14th Sts., to E. W. Sproul, 201 Oak St., Kansas City, Mo. Estimated cost $200,000.

Kan., Kansas City—The city, G. T. Darby, Purch. Agt., City Hall Bldg., awarded the contract for six 1,000 kva. out door type, oil insulated, self cooled transformers, 60 cycle, single phase, 13,200 volts, high voltage, 6,600-2,300 volts, low voltage, to the Westinghouse Electric & Mfg. Co., Leslie Bldg., $18,050. Noted Aug. 29.

Mass., Holyoke—The Farr Alpaca Co., Jackson St., awarded the contract for a 6 story, 100 x 500 ft. cotton warp plant, to the Daniel O'Connell's Sons Co., 480 Hampden St. Estimated cost $600,000. Steam heating system and electric power plant will be installed. Noted Aug. 1.

Mich., Detroit—The Bd. of Educ. awarded the contracts for 3 story, 168 x 334 ft. school on Selden & Hamilton Aves, to A. A. Albrecht, 540 Penobscot Bldg., $748,250; 2 story, 105 x 145 ft. school on Kerwin Ave., to Martin & Krausmann, 606 Woodward Ave., $202,492; 2 story, 85 x 135 ft. and 78 x 90 ft. addition on Congress St., to G. Worswick, 3280 Whitney Ave., $209,726. Steam heating and Plenum ventilating systems will be installed.

Mich., Grand Rapids—The Grand Rapids Tire & Rubber Co., Fuller St., will build a 3 story, 44 x 226 ft. factory. Estimated cost $250,000. Private plans. H. F. Swan, Purch. Agt., c/o owners, is in the market for milling machine, rubber working machinery, etc.

Minn., Carlton—Carlton County awarded contracts for a 3 story, 78 x 125 ft. courthouse, to J. J. Niebuhr, 2822 Penn Ave., $218,187; heating and plumbing to Bruno & Lundell, Cloquet, $21,643.

Minn., Crookston—St. Benedict's Academy, c/o Benedictine Sisters, awarded the contract for a 3 story, 50 x 220 ft. school, to G. Schwartz & Co., Rochester, Minn., about $225,000. A steam heating system will be installed.

Minn., Minneapolis—The Burton Investment Co., 733 1st National-Soo Line Bldg., awarded the contract for a 3 story, 110 x 192 ft. apartment building, including mechanical equipment, on 25½ St. and Humboldt Ave. S., to the Fleisher Constr. Co., 1000 Builders Exch. Bldg., about $250,000.

N. Y., Falconer—The Niagara, Lockport & Ontario Power Co., Lockport, awarded the contract for a 2 story, 60 x 100 ft. substation on South Dow St., to the Jamestown Constr. Co., 60 River St., Jamestown. Estimated cost $50,000. Noted June 20.

N. Y., Hornell—The Hornell Electric Co., 30 Canisteo St., will build a 5 mi. high power transmission line to Arkport. Estimated cost $25,000. Engineer not announced.

N. Y., New York—The Bd. Educ., 500 Park Ave., awarded the contract for an addition to the Julia Richman high school on 67th and 68th Sts., to Frymier & Hanna, 25 West 45th St., $1,864,000. Noted Aug. 15.

N. Y., New York—The Burroughs-Wellcome Co., 18 East 41st St., awarded the contract for a 12 story, 45 x 100 ft. store and office building at 9 East 41st St., to Fountain & Choate, 110 East 23rd St. Estimated cost $1,250,000. A steam heating system will be installed.

N. Y., New York—The 49 West 45th St. Corp., c/o Sommerfeld & Steckler, Archts., 31 Union Sq., awarded the contract for an office building at 49 West 45th St., to the G. Backer Constr. Co., 285 5th Ave. Estimated cost $300,000. This corrects report in Aug. 22 issue.

N. Y., New York—The Prudence Bond Corp., 31 Nassau St., awarded the contract for a 4 story, 66 x 100 ft. office building on Madison Ave. and 43rd St., to the Realty Assoc., 162 Remsen St., Brooklyn.

N. C., Lincolnton—The city awarded the contract for a 200,000 gal. reservoir, pump and motor equipment, also 6 mi. 6 to 10 in. sewer line and 2 mi. 6 in. water mains, to Boyd-Higgins & Goforth, Charlotte, $60,000.

Ohio, Orient—The Dept. Public Welfare, Ninth and Oak Sts., Columbus, awarded the contract for six 2 story cottages, two 65 x 135 ft., 4 consisting of 6 wings, each 30 x 110 ft., for the Institution for Feeble Minded, here, to D. W. McGrath & Sons, 255 East Broad St., Columbus, $639,836.

Pa., Phila.—E. Hummel, c/o Martin & Kilpatrick, Archts., Otis Bldg., awarded the contract for an 8 story, 22 x 153 ft. office building on 20th and Chestnut Sts., to W. R. Dougherty, 1610 Sansom St. Estimated cost $500,000. A vapor heating system will be installed.

Pa., Phila.—The Fred Pearson Co., 11th and Chestnut Sts., awarded the contract for a 5 story, 62 x 160 ft. textile factory on Leverington and Wilde Sts., to H. H. Burrell, 206 South Quince St. Estimated cost $300,000. A steam heating system will be installed.

Pa., Pittsburgh—The Duquesne University, Bluff St., awarded the contract for a 3 story, 80 x 125 ft. gymnasium building and a power house on Colber and Locust Sts., to Rose & Fisher, 819 Pennsylvania Ave. Estimated cost $150,000. Noted Aug. 15.

Pa., Williamsport—The Stewart Artificial Ice Co., awarded the contract for a 1 story, 35 x 75 ft. addition to ice plant on 1st St., to C. Springman. Estimated cost $15,000. Machinery and equipment for ice freezing plant will be installed.

S. D., Murdo—The city awarded the contract for a complete waterworks system, including pumping station and equipment, elevated tank, earth dam, hydrants, 12,740 ft. of watermains, etc., to W. D. Lovell, 1415 Southeast 8th St., Minneapolis, Minn., about $27,000. Noted July 18.

Wis., Spring Green—The city awarded the contract for constructing and equipping a pumping station at the waterworks, to E. H. Hutter. Estimated cost $25,000. Noted Aug. 8.

Wis., Stevens Point—The city awarded the contracts for waterworks improvements as follows: erecting pumping station and digging a 30 in. well 32 ft. deep, to the Cast Stone Constr. Co., Michigan Ave., Eau Claire, about $7,000; furnishing and installing one 1,000 gal. and one 1,500 gal. directly connected centrifugal pumps, motor driven, to the Ingersoll Rand Co., 343 South Dearborn St., Chicago, Ill., about $4,000; laying of 19,200 lin.ft. of 6 to 16 in. c.i. pipe, to the J. E. McVicker & Co., $15,000. Noted May 2, 1922.

Wis., Wausau—The Wausau Memorial Hospital, c/o O. C. Lemke, Cleveland Ave. and Thomas St., awarded the contract for a 4 story hospital to the Wisconsin Engr. & Constr. Co., 512 3rd St. Estimated cost $250,000.